RAILWAY ENGINEERING AND MAINTENANCE OF WAY.

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Vol. VI | *Chicago* | DECEMBER, 1910 | *New York* | No. 12

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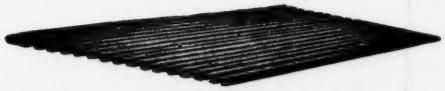

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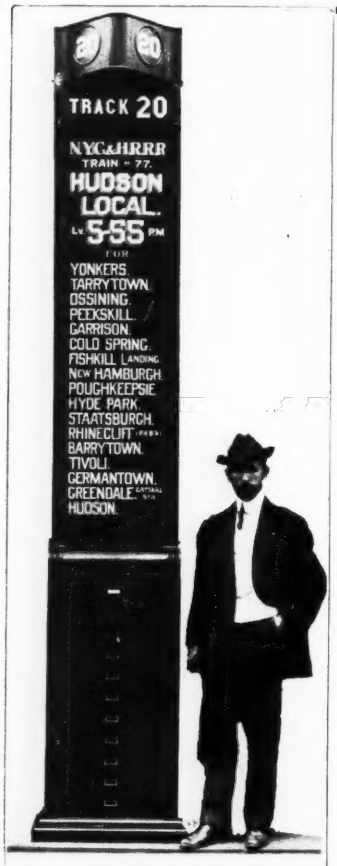

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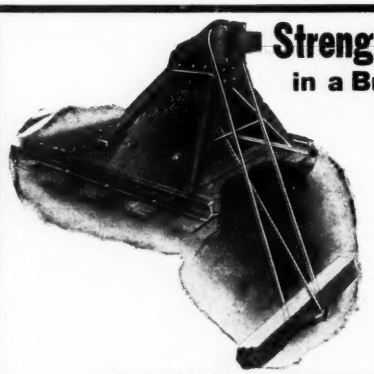

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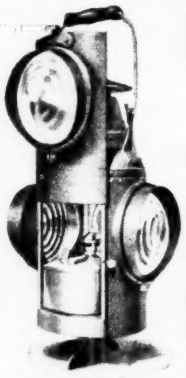

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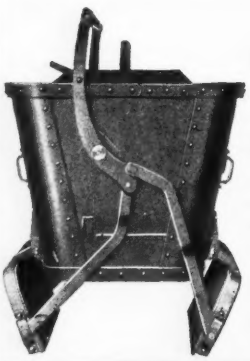

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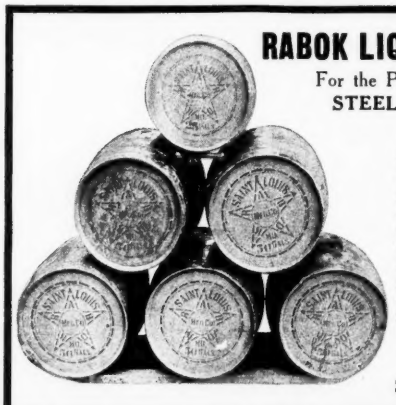

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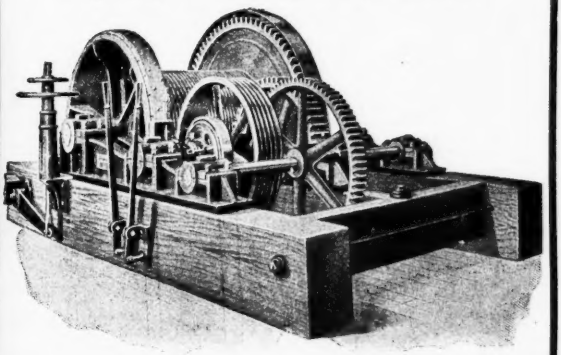

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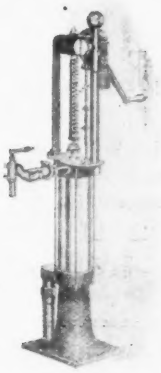

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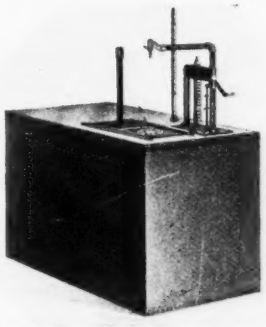

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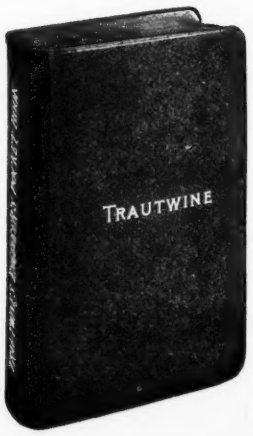

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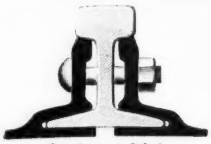

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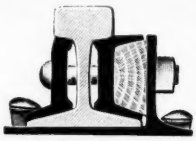

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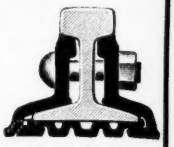

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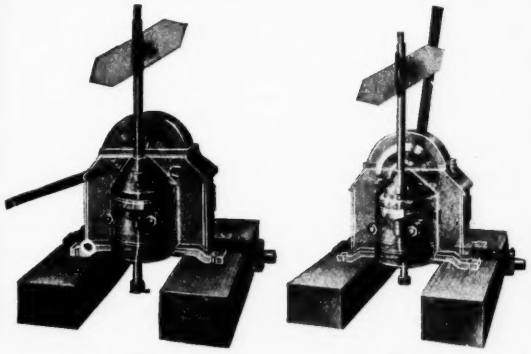
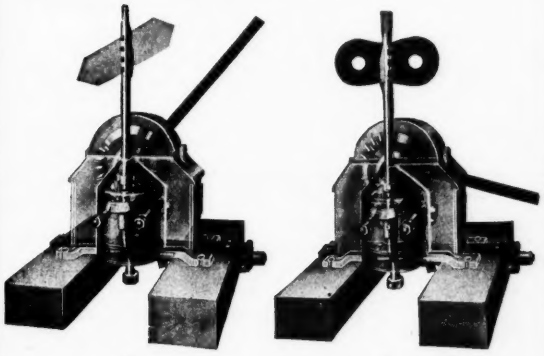


1 2

Moving the lever from 1 to 2 closes switch; from 2 to 3 interlocks points; from 3 to 4 clears home and distant signals.

Moving lever from 4 to 3 sets home and distant signals to danger; from 3 to 2 withdraws interlock; from 2 to 1 opens switch.



3 4

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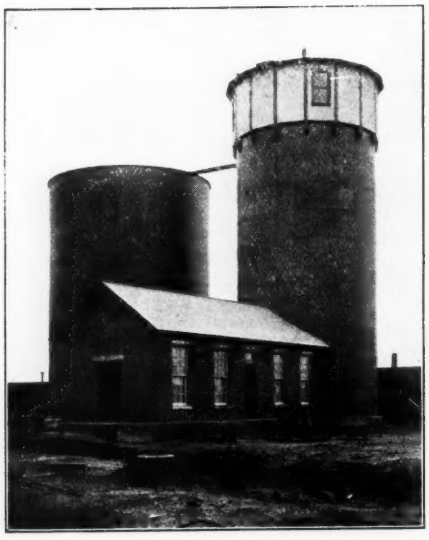

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COMEDY.

THE SPECTACLE of a lawyer attempting to teach the railroads how to conduct their operations and of the railroads asserting that there is no possibility of improvement in their methods, is indeed a sight for the gods, and a worthy contribution to the joy of the nations. Justly very little attention should be paid to one who, lacking totally in experience, attempts to give advice. Likewise scant courtesy should be paid to the derisive assertions of the railroad representatives. That there is vast room for improvement in railroad operation, and that great economies could be effected, no thinking man at all conversant with the situation will deny. For example, a railroad will buy a number of locomotives. These are paid for on delivery, but it happens that this occurs near the end of the fiscal year. Forces have been reduced so as to obtain a favorable showing in the comparative statement. Therefore, the locomotives, instead of being assembled, broken in and put to work to earn money for the road, are stored away for one, two or three months, during which time interest charges, rust and other things accumulate which are a total loss. Just before the last panic a large eastern road had arranged for the installation of automatic block signals on an important division. The signals had been erected and construction had progressed to the point where wiring up alone remained to be done when the money stringency occurred. Work was stopped and the signals allowed to stand for over a year before being put in service. Here was a loss of interest, deterioration of property and the assumption of collision risks, not to mention lack of capacity due to the want of a few thousand dollars that might have been borrowed. Again, a western road built a pole line along its right of way. The poles had been up not more than a month when it was decided to build a new track necessitating their removal to the other side of the right of way. Doubtless our readers can recall numerous additional instances of inefficiency.

The first two cases cited are examples of what has come to be known as "headquarters economy" and is due to financial short-sightedness. The last case was due to lack of co-operation between departments. This sort of inefficiency can be cured by vigorous action on the part of the general manager, the other sort will never be cured until our operating officials are allowed to run the roads instead of being overruled by stock market expediency.

THE SIGNAL DEPARTMENT.

THE PENNSYLVANIA standards are particularly interesting, as this road was a pioneer in the art of signaling in the United States, as well as in the adoption of the upper quadrant method. The first interlocking machine erected in this country was installed on the Pennsylvania, as well as the first automatic block signals used for the spacing of trains.

On this road is the most extensive installation of electro-pneumatic signals and interlocking plants in the world. This type of power is invariably used by the Pennsylvania wherever the traffic warrants the expense.

It is our understanding that speed signaling, as distinguished from route signaling, was first used on the Pennsylvania. In any event, Mr. A. H. Rudd, the signal engineer, was one of the originators of the idea. This idea is the basis of the recommendations of Committee No. 1 of the R. S. A., which has been the subject of such bitter controversy lately in the Signal and Maintenance of Way associations. This system has been adopted by the Pennsylvania as standard, and we believe also by the Baltimore & Ohio.

Although the Pennsylvania was very thoroughly equipped with lower quadrant, two position signals, yet when the upper quadrant idea was introduced and its advantages understood, the Pennsylvania was one of the first roads to adopt it. It now has many such signals in service. The type of spectacle first used was quite different from the present R. S. A. standard, the whole weight of metal being on one side of the spindle.

This is the safest method of handling such a device that has come to our notice.

Among the published standards, the one most worthy of note is the method of equipping a pipe connected crossover.

J. J. Hill on the Outlook.

That the United States—and the world, in fact—will soon harvest the fruit of extravagance, J. J. Hill is absolutely positive. The country faces no panic and matters will finally ad-

just themselves; but the American people are too complacent. They spend too freely and are greatly inclined to take a rosy view of things entirely unwarranted by circumstances.

"Extravagance has been our great fault. We have been wasting entirely too much in non-productive undertakings. As a rule we have been given too much to adornments. We have become obsessed with 'the city beautiful' in municipal affairs. We have followed like policies in the state and national governments. Battleships, not only in this country, but also abroad, are illustrations of the extravagance in which the world has been plunged for the last two decades. The money for the construction of these has been withdrawn from commercial circles and almost as good as squandered so far as any tangible returns can be observed.

"If a man buys a farm and cultivates it, he contributes to the material wealth of society. If he permits the land to lie idle he has subtracted from the general wealth by withdrawing his money from commerce and investing it in a non-profitable enterprise. This illustration serves to indicate our trend in all departments of our government.

"Do you hear of any generally systematic plans for improvements during the next year? There is none. Factories and such other enterprises which are productive in their nature and which contribute to wealth are not contemplated by those who have the money to invest. This means that those who have nothing to sell but their time will be without employment. There will have to be shutting down of the mines because iron and coal and other minerals that go into production of commercial articles will not be in demand. The same might be said about the lumber business and other forms of activity.

"In preparing our Great Northern orders for next year we find that we are going to need very few supplies. This is because we are making no extensions. Last year we ordered 245,000 tons of rails and had no surplus. For the next year we will need only about 70,000 tons. Last year we had to have 11,000 new freight cars; this year we shall need but 3,000. Last year a large number of passenger coaches; this year we shall need none. We ordered over 300 locomotives last year; twenty new ones will be an abundance for next season."—*Newspaper Interview.*

Wood Preservation from an Engineering Standpoint.

(Continued.)

Suppose a pile in use, as illustrated; that part of the timber between high and low water decays first. Suppose there are holes provided which will permit the replacement of the preservative (leached out) by filling these with a fresh supply. Would the capillarity in the wood transfer the preservative outwardly from the central cavity? A plug would close the opening.

Suppose a railroad tie with holes bored in from the ends, and provided with plugs which will permit the introduction of the preservative. Would that be of practical value?

Mr. Barnum: I think perhaps that would work all right. An application for a patent involving the same principle has recently been sent to the department. It is to be used in connection with treating telephone poles in position. A hole is first bored in the pole and then a small receptacle, constructed of pipe, is attached. After the pipe is in position it is filled with creosote and allowed to remain. The preservative is then gradually taken into the wood by capillary attraction. At first there were to be three openings in the pole, 120 degrees apart, and three connections leading to the main pipe. Afterwards one was found to be sufficient. A section of a pole treated in this way was sent to the department also. It showed a good penetration of creosote, of about 1½ ins. The patentees claim they can get about 12 lbs. of creosote into a pole. The scheme looks as if it might be practicable, but it has not yet been thoroughly tested.

Mr. Kandeler: How far above the ground would the treating be begun?

Mr. Barnum: About a foot to eighteen inches above the ground would be sufficient. In the South the whole pole must be treated. In this part of the country I think it is only necessary to treat the butt of the pole. It is claimed that good results are secured with this treatment.

Mr. Chanute: By way of explanation, I will state that the idea of boring a hole in a stick of timber, in order to introduce a preservative substance, is a very old and natural one, but it was found that the results were quite unsatisfactory, in consequence of the fact that the structure of the wood is such that the sap cells chiefly communicate lengthwise with each other, so that with a given piece of timber about three-quarters of the solution goes in through the ends and about one-quarter through the medullary rays. Now, the only way in which creosote, bottled up in a hole in timber, can saturate the rest of the wood is through the medullary rays, and that has been found inefficient.

The President: I will ask Mr. Barnum if he can give us a description of the non-pressure process.

Mr. Barnum: The non-pressure process has received the support of the Forest Service because it is believed to supply the need of the small consumer who cannot afford to go to the expense of putting in a large plant with its complicated equipment. Several of these plants have been erected in the South for treating short-leaf and loblolly pine. The preservative is forced into the wood by atmospheric pressure. The wood is run in an ordinary cylinder, the cylinder being made of very light—¼-in.—iron, and then oil is admitter and heated up to 220 or 230 degs. F. This hot bath lasts from two to three hours and expels part of the air and moisture in the wood cells. The hot oil is then withdrawn from the cylinder and immediately replaced by cold oil. The charge of cold oil causes the expanded air to contract and a vacuum is formed which is destroyed by the entering oil forced in by the greater pressure of the atmosphere. Very good results have been secured in treating porous wood with this process, and it is comparatively easy to get the preservative all the way through loblolly and short-leaf pine—clear up to the heart. Good results have also been secured in treating red oak ties by the non-pressure process, but the red oak is more difficult to treat than pine. Of course, the non-pressure process can by no means take the place of the pressure process. It is simply advantageous for the treatment of very porous wood, where the amount of money available for the construction of a plant is comparatively small.

Mr. Chanute: I will say that if that process can inject an average of 12 lbs. of solution to the cubic foot, we do not need anything better.

Mr. Curtis: In the treatment by the ordinary pressure process, one does not depend upon first heating the wood and then chilling it by the cold oil to produce the vacuum. This is done much better by a vacuum pump and then supplementing the atmospheric pressure by pump pressure. I have never got too much oil penetration in the ties, even with a 24-in. vacuum and 150 lbs. pressure. I have never seen an oak tie in which I could get that degree of penetration which I think we ought to have. I do not know that I have ever treated loblolly pine ties by the full-cell process, but I have treated a great many thousand such ties by the Rueping process. With that process we first produce in the cylinder 50 lbs. air pressure, and then run in the oil and put on 150 lbs. of oil pressure. If the loblolly pine ties have been well seasoned, on cutting a tie in the middle it will be found treated right down to the heart, although not all the

way through as a rule. It is difficult to get the solution into the heart, which, of course, will vary somewhat in size, but ordinarily it will come down to a 1½ to 2-in. ring. In other words, it was as fine a treatment as one could expect to get.

In regard to oak and some of the other hard woods, I have never been able to get uniform results. Investigation will show good treatment in one instance, while in another instance the treatment would be superficial. I do not doubt that Mr. Barnum has been able to get good results with sapwood and loblolly pine when well seasoned. But unfortunately in the timber-treating business one wants to get uniformly good results. Of course, absolutely uniform results cannot be obtained by any process, but we are aiming to reduce the percentage of poor results. I remember that Mr. Chanute became discouraged at one time with tamarack wood because he could not get absolutely uniform results. I am in some doubt as to the results which we are going to find in this country 10 years from now, with the oak ties we are treating with oil to-day. Some of the results which have been secured in oak, in this country, with the zinc chloride process, have been remarkably good, and some much better than I was ever sanguine enough to anticipate. I think the first year that the Carbondale plant was run it treated a lot of red-oak ties for southern Illinois, where the rainfall was about 60 inches, and the last report I had was that those ties showed up remarkably well. However, I should never anticipate very great results from red-oak ties laid in that territory. There is a good deal of clay there, which is a great water holder. The rainfall, too, is very heavy. The results from treating timber with zinc chloride have been remarkably satisfactory.

I believe that there are many things to be learned about timber, and about treating it, and I am hoping that Mr. Barnum will teach us how to secure those uniformly good results that we are all looking for. I have tested a great many sticks and have been surprised and disgusted by the failure to get results. This summer it was necessary to treat a lot of long-leaf yellow pine soon after it was sawed. It was given a much longer treatment and more steaming than usual. The steaming was continued for six hours at a reasonably high pressure—the oil pressure was 165 lbs. The work was done in a plant where I know the treatment was absolutely conscientious, yet on sawing some of those sticks in the middle the results were very disappointing. I reached the conclusion that if I had any more timber to treat freshsawed, it must be loblolly pine, as long-leaf pine is not fit to be so treated. The vast difference between the penetrability of timber to a water solution and to oil is a curious thing.

Mr. Barnum: The Pennsylvania Railroad has recently built a new plant, where they are treating red-oak wood, and are getting a thorough penetration. The ordinary oil pressure treatment is given, after which an air pressure of 100 lbs. per sq. in. is placed on the timber. This air pressure is held for about half an hour. When the air pressure is released a vacuum is drawn and held for the same period. The air pressure and vacuum diffuse the oil entirely through the wood in a uniform manner.

The President: I recently saw some samples of timber treated by a process applying a pressure at one end of the stick, with a vacuum at the other end. Can any one tell us about that process?

Mr. Curtis: It is only a modification of the old Boucherie process. There are other methods similar to that you mention, excepting in minor details. There is no virtue in the vacuum; it exists only through absence of pressure, and an increase of pressure at the other end amounts to the same thing.

L. J. Hotchkiss: I should like to ask if douglas fir takes treatment satisfactorily. We are using a great deal of this timber and I have been told that it cannot be successfully treated. If any one here has tried to do it, I wish he would tell us what his experience has been.

I should also like to ask as to the relative merits of treating timber which has been air-seasoned, and of taking it green and steaming it as a part of the treating process. Not long ago I was talking with a man who is in the business of treating timber, and he advocated steaming it. His idea is that the life of a stick of timber is only a certain number of years, and if it is air-seasoned before treating, the time required for this seasoning is just so much of its useful life lost. He thinks if it is steamed instead, this loss is avoided with no injury to the timber to offset it. I should like to know the opinion of others on this point.

Mr. Chanute: In regard to Mr. Hotchkiss' second inquiry, with reference to steaming. We have tried several hundred experiments in order to determine the advantage or disadvantage of steaming, and found that, in order to extract the sap, it was necessary to have some motive power. If the wood was partly seasoned the sap has evaporated to a good degree and air has flown into the sap cells. Now, by steaming, the air is heated and drives the sap out of the cells. If the timber is fresh cut and full of sap you have got to apply sufficient heat to the center of the tie to generate steam—or a heat of 212 degs.—in order to drive out the sap and replace the action of the heated air. We took ties and steamed them one, three, five, six, seven and twelve hours. We bored holes in them, which we plugged up, and after the tie came out we removed the plug and inserted a thermometer to ascertain what the temperature was. We found we got a temperature of 212 degs. F. with not less than 8 hours' steaming. In creosoting piles in the South, I understand in some cases they are steamed 24 hours before the sap can be extracted and the creosote put in.

With respect to the first question asked by Mr. Hotchkiss, as to whether douglas fir takes treatment satisfactorily or not, I may say that the Southern Pacific R. R. claim they treat it better when it is fresh cut than after it is seasoned, and all the ties which they are treating are treated fresh cut. I thought the statements extraordinary, and went out to California to investigate the matter. I found that the information was correct,—that the douglas fir, fresh cut, was more easily treated (by steaming) than when seasoned, the reason being that the douglas fir contains a good deal of resin. That resin is fluid when the wood is fresh cut, but after the wood has been cut for a while the resin gums in the cells and resists the injection of the solution.

Mr Curtis: I simply want to supplement what Mr. Chanute has said. If Mr. Hotchkiss refers to the treatment of timber with oil, the proposition is somewhat different. I have never had an opportunity to treat douglas fir, but believe it cannot be done by the ordinary pressure method. The only way I know of to treat douglas fir timber satisfactorily with oil is by boiling it in the oil and supplementing by pressure. In that way a penetration is obtained which is satisfactory.

C. F. Loweth: Referring to Mr. Hotchkiss' question about the treating of douglas fir, I will say that about a year or so ago we contracted with a reputable and experienced wood-treating plant to treat a lot of douglas fir timber. The company assured us that although they had not been treating douglas fir, they were confident they knew how to do it. They made an energetic, and I believe an honest effort, but the result was a failure. The timbers to be treated were the ordinary pilebridge stringers, 8x16 in. in section by 32 ft. in length; they had been lying in a yard for a couple of years or more and were thoroughly seasoned. Notwithstand-

ing the efforts of the firm to treat this timber, it appeared impossible to force the creosote in at the sides and rarely was the penetration as much as ⅛ in. in depth; but it was quite easy to force the creosote into the ends of the timbers, and in some cases at a distance of 8 ft. from the ends, as I remember it, about half of the section of the timber would be saturated and doubtless the penetration from the ends extended a very considerable distance. This left the skin or surface, of the stick with a very imperfect and inadequate protection, because a very slight season-check would open up a portion of the interior which had received no treatment. The people made many efforts, experimenting one way and then another, and in several cases the timbers were very badly distorted by the unequal heating, etc. I am inclined to think that fir timber can best be treated while green and by what is known as the boiling treatment.

Those same people at that time had another unexpected experience. Their order included some 8x8 in. 12 ft. long Minnesota white pine bridge ties. White pine is very rare nowadays, at least for such purposes. It was generally supposed that this material would take treatment as easily as loblolly pine; but this was soon discovered to be a mistake, for the ties did not take the treatment, and, what was more surprising, the contractors were not able to find out how to get the creosote into the timber. The best that could be done seemed little better than what might have been obtained by merely soaking the timber in a bath of crosote. I turned some of the samples over to Mr. Curtis, who took them to one of his treating-plants and tried his method or methods, but I dare not mention the results. The white pine ties were freshly cut and full of sap and frost.

Mr. Curtis: Mr. Loweth sent to me, at my request, four samples 8 in. by 8 in., 6 ft. long, as pretty samples of white pine as I have ever seen. I expected to fill them so full of oil that they would be dripping for six months. I put one piece in the cylinder with a run of piling, and after taking it out and cutting it I was ashamed to show it to Mr. Loweth. I tried another sample by the Rueping process, and curiously enough (though we did not have the same oil pressure by 50 lbs. as we did on the first trial) on that sample we got a good treatment. Other tests by the same method, however, were unsatisfactory.

When one gets into the subject of timber, no matter how expert he may be, he is going to have some surprises. I would not have believed that I could have any difficulty in treating white pine. I believe that it can be done, but I will admit that I do not know how.

The Hoskins Rail Chair Company, with Zachary T. Hoskins President, Charles W. Bush Vice-president, N. L. Towle Secretary and Treasurer was incorporated in Willmington, Del., August the 29th, 1910. Capital stock $1,000,000. With the object of making and selling the Hoskins rail chair. The Chicago office is at 12 State street. They claim a decided improvement over any other continuous or base supported rail joint, now on the market. They do not claim, however, to be exclusive makers of rail joints, but do claim to be exclusive makers of the Hoskins rail chair. One of the features of this joint, which they claim is a decided improvement over other continuous or base supported joints, is that in those now manufactured, the rail joint re-enforces the rails so strongly that it stops the wave motion of the rails abruptly at the end of the Joint. The Hoskins rail chair, being cut out for several inches from the end, in order to make a tie plate, allows this wave motion gradually to cease. This prevents the breakage of rails which now occasionally occurs with continuous joints. Another advantage they claim is that the Hoskins rail chair, having combined a tie plate with a rail joint, the additional cost of tie plates on the joint ties and anchoring the rail to the joint is saved; therefore, it should not be necessary to use anti-creepers on the rail which is another source of saving in using the Hoskins rail chair over ordinary continuous joints. They also claim that their improvements make a stronger and safer rail joint and one as easily put on as an angle bar and that it can be furnished as cheaply as other continuous or base supported rail joints.

The Testing Department of a Railroad.

By B. S. Hinckley.*

The testing department is the result of natural development in the modern organization of any well managed railroad. The existence of such a department in itself demonstrates that money is saved by supporting it and when we consider that the greater part of the economy is indirect and invisible, so far as actual accounting will show—it is the more commendable to the shrewd insight of the management in appropriating thousands of dollars each year for its support.

Only recently has a testing department been considered of any special value to the large corporations who heretofore have considered such a department one of expense only and one not necessary to secure the greatest possible economy of operation. Today we rarely find a live railroad without its testing department.

The question arises, quite naturally, why has this new department, this additional expense, been developed as a most essential adjunct and an added revenue earner for its corporation? It is because such a department can handle the diffiicult problems concerning material and design, problems that require for their solution practical experience and theoretical knowledge combined. Primarily the testing department works hand in hand with the department of purchases. The basis of all the work of an analytical and testing laboratory is the preparation and execution of the specifications for the material under investigation. In this class of work it is of the utmost importance for the purchaser or consumer to bear in mind, that nothing should be embodied in the specifications for any material that will tend to increase the cost of that material to an amount over and above a price at which a satisfactory grade of material under consideration can be purchased in the open market and taken from the reserve stocks of large manufacturers. In other words, while the specification should be made sufficiently rigid to protect the purchaser from substitution of inferior or adulterated material, they should not go to the other extreme and place such restrictions on the method of manufacture that the manufacturer cannot produce the goods without upsetting the ordinary routine of his daily operations, and adopt, or be forced to adopt, methods entirely foreign to his common practice.

There are many manufacturers and contractors by whom the word "specification" is uttered with a feeling of irony—the word leaves a bad taste in their mouths; they consider specifications unnecessary, discriminating, and very frequently unfair. The engineering profession alone is responsible for this feeling, for the reason that so many specifications have been prepared without proper regard for the interests of the manufacturer or contactor and involve only the interests of the purchaser.

The work of the department is as closely related to commercial life as the traffic department or the purchasing department. The men of the testing department become familiar with the qualities and value of raw materials as well as with the manufacture of almost every conceivable product of our mills and factories. It is the desire of the testing

*A paper read before the New York Railroad Club.

department that it be considered a bureau of consulting engineers and chemists and not a department whose main object is to find fault and offer destructive criticism. Our whole object is to build up—to formulate and have executed specifications that are satisfactory to both the manufacturer and the railroad. Without specifications the only protection at hand for the railroad is careful inspection and accurate records of the service of material bought on a guarantee basis. We will admit that many classes of material are bought more economically on a guarantee basis than on specification but of what use is the guarantee if it is everybody's business (which means nobody's business), to see that the guarantee is fulfilled.

Among the supplies that may be more economically bought on a guarantee basis are rubber goods, paints and possibly bearing metals. In the manufacture of these materials there are perhaps secret tricks of the trade which give to a particular brand its own particularly valuable characteristic and a chemist may never be able to reveal just what treatment is given outside of mixing together various quantities of separate ingredients which he is able to discover. The layman is not in a position to dictate to a manufacturer how he shall make his product; he may advise him what service he will expect from it but he must leave it to the manufacturer to produce the article.

As may be expected of a department just coming to its own—a department considered by short sighted and penurious managements as an unnecessary expense—the size and importance of the testing department on the railroads of this country are small compared to what they should be. On a great many roads the man or men in charge of testing materials and equipment are employees of the mechanical department and report eihter directly or indirectly to a motive power official. This is a great mistake—it is just as absurd as it would be to have the auditor of accounts report to the cashier. The testing department should be independent of all mechanical or engineering departments, for the chief economical results are secured only by giving freedom to the department of tests in its work of checking the quality, handling, and use of the materials purchased.

What the testing department should do is to show up defective material, not only at the factory and mill, but after it has reached its destination and been applied to the equipment, road-bed or structure. From a disinterested point of view the testing department should follow up the service of material and apparatus applied to the locomotives and cars, or bridges and buildings, should be free to say plainly wherein one device or another was not economical although possibly that device might be in the opinion of the motive power man, or the chief engineer, the best for the purpose. The necessary independent and unbiased investigations and reports are impossible from a subordinate to his superior when the subordinate knows that his reports may be embarassing to the man to whom he reports. If the testing department is directly or indirectly under a mechanical department head or under the chief engineer, it is quite certain that materials, patent devices or mechanical specialties, not appealing to the chiefs of these departments will be found of no value to that company and that reports which in any way reflect on the efficiency or economies of the mechanical department or the engineering department might be safely consigned to the dusty archives and copies not forwarded to the man in charge of purchases.

The need of laboratory and service tests was naturally first felt by the mechanical department and this class of work was handed over to men acquainted with technical investigations. These men were in many cases college graduates who had chosen railroad work for their occupation. Some were special apprentices, others perhaps draughtsmen or bright, young machinists' apprentices. They spent a portion of their time doing this test work and finally the whole time of one man was required to handle the work. The man was usually a chemist for the mechanical test work could be handled by the force of the mechanical engineer or chief draughtsman. On many roads today and many of them large systems—this condition still prevails and anyone taking the time superficially to look over the quality of material received by these railroads will be impressed with the necessity for a quick development of testing work and the proper organization of a testing department.

Even a single employee would produce good results if he were allowed to report to the proper official but usually, if not always, where the test work is handled by one or a few men, they are subordinate to the mechanical officer and their efficiency practically eliminated thereby. The motive power and engineering departments, are the departments using or having jurisdiction over most of the material and supplies purchased by a railroad company. Why should either of these departments have charge of examining and testing this material? Wherein is there any protection for the supply house which is on the outside, where is there any protection for the railroad against favoritism and how can the official in charge of purchases know the true relative merit of the various materials on which he has secured prices? As said before the testing department should be independent of all operating and engineering departments—the man at the head of the department, the engineer of tests, or whatever title he may have, should report to the highest official having any jurisdiction over the purchases. Only in this way and by such organization is full benefit secured.

While as stated, the testing department should be directly responsible to the highest official having jurisdiction over purchases, it should be the right and privilege of the heads of all departments of the road to request investigations, analyses or tests of any proposition, material or device in which they may be interested or many consider worthy of attention. Reports on these matters should be sent to the department head submitting the proposition and copy of the report sent to the official to whom the head of the testing department is directly responsible.

The greatest single item of expense for a railroad outside of payrolls and equipment, is the coal bill. One of the greatest economies that can be instituted on a railroad is to give practically full jurisdiction of the fuel supply to the testing department. By careful, systematic checking of the coal shipments from the mines to its consumption at the firebox door—by correct sampling, analyses and tests very material economies can be obtained. All of this work can well be handled by the testing department and it is safe to say the visible saving from this one branch of the work will cover the cost of the maintenance of the testing department many times over.

Frequent statements are made that proper inspection and tests of bridge material can not be handled economically by the testing department of a railroad. These same people will say that it is better to employ the outside bureaus and pay a certain price per ton for the mill and shop inspection. This all depends on the size and importance of the testing department under consideration. It is easily possible to handle this work satisfactorily and economically if the railroad can keep men busy in the territory where the bridge material is being made. The same men can cover an area of one or two hundred miles radius and handle the inspection of other classes of material purchased within that area. These men should be resident inspectors in the city where the greater part of their work is located and they should be reimbursed for all expenses incurred outside of their home city. In rare cases the outside bureaus should be used—this will

occur when the tonnage to be inspected is too small to warrant the expenditure of salary and traveling expenses of the railroad's inspector. In handling the inspection of bridge material in this way the railroad company secures more loyal and interested inspection than can be possible when the outside bureaus are given a blanket contract to handle the entire inspection of the bridge material. Naturally each road must decide on this matter as best suits its conditions and organization.

The inspection of new equipment—locomotives, cars, both passenger and freight, at the builder's shops, is another line of work that may very profitably be left to the testing department. This method of handling the work is not common, but where it has been tried, it has proved quite satisfactory. Owing to the fact that this work may at one time be rushed and at another dropped altogether it is of no advantage to have men retained on the payroll of the testing department to handle this work alone. Practical men taken direct from the shops are best fitted for the work as they are acquainted with the standard practice of the company. On this account men should be selected from the shop forces and temporarily turned over to the testing department so far as reports are concerned. It is not necessary to remove them from the payroll of the mechanical department. This arrangement is quite necessary on account of the close connection of the material inspection with the use of the material in the construction of the equipment. Furthermore the highest official in charge of the purchases is kept in close touch with the character of work and materials furnished by the builder.

Where a railroad produces on its line of road a substantial percentage of its tie supply the testing department, which naturally handles the inspection of the ties and timber, can very readily have charge of the collection and distribution of the ties. The specifications for ties should be so drawn that it is made clear to the tie producer—that by the actual inspection of the tie the purchase of the accepted tie is completed by the railroad. This is quite necessary to protect the railroad from dissatisfied tie producers who otherwise might say they would not accept the inspection of the railroad and haul away the ties which the railroad had accepted and this would mean a loss of the inspector's time as well as the time of the men used in handling the ties. So closely is the inspection and purchase of ties related that it becomes naturally the work of the testing department to handle entirely the tie supply. The inspectors are advised daily to whom the ties should be consigned and in the office of the engineer of tests are the complete records of purchase, inspection, shipment and disposition of all the ties as well as native timber.

The tie and timber division of the work is further closely related to test work in the case of treated ties or timber. Where the railroad is not equipped with its own treating plant the inspection of the process of treatment and analysis of the creosote oil used is handled naturally by the laboratory force. The time is coming and that day is not far off when the eastern roads will find it advisable to treat a portion, if not all the ties used each year. There is money made in treating ties and timber, and a large portion of this money may be reclaimed by the railroad company that is progressive enough to have installed either under its own management or that of a reliable creosoting company one or more creosoting plants on its own line of road. These plants should be located either in the center of the tie producing districts on its own line or at some seaport to which ties can be shipped at reasonable rates. The supervision of such plants in case they are owned by the railroad or the inspection of the work at these plants in case they are operated by outside companies should be handled by the testing department.

An additional advantage and one resulting in substantial savings to the company maintaining its testing department is the prevention of legal suits against the company. The very valuable records and reports contained in the files of the laboratory are of permanent value in case of damage suits, traceable to material or equipment failures. Suits have been withdrawn entirely as a result of unanswerable evidence and proof incorporated in the reports of the laboratory assistants who have been detailed to investigate the claims made by the complainant's attorney.

Form A)

THE A. B. C. RAILROAD CO.

DEPARTMENT OF TESTS

Report of Tests, for ..... Shop Contract, No. .....

Material ..... Rolled by ..... Date 191

Ordered by 191

No. of Pieces	Rolled Section	Length Feet	Length Inches	Weight	Melt Number	Yield Point lbs. per sq. in.	Ultimate Tensil Strength lbs. per s.q. in.	Elong. per cent. in 8 ins.	Red. of Area per cent.	Frac. ture	Bend	Chemical Analysis C	Ph.	Mn.	Si

Note ..... Correct ..... Chief Inspector.

Fracture is fine, unless otherwise noted. Approved ..... Engineer of Tests

A representative case of this sort arose when an oyster grower made complaint that the waste water from a roundhouse being contaminated with oil was killing his young oysters in a bed located near the roundhouse. Under the directions of the chief chemist a small oyster bed was planted in the vicinity of the seat of trouble and enough evidence secured to eliminate all liability on the part of the railroad to the oyster grower.

In addition to the tests and analyses of material, the inspection of equipment and investigations on special subjects pertaining to all branches of railroad work, the testing department is in a position to handle the manufacture of numerous supplies on which a great saving may be shown. Among such supplies may be named dry fire extinguishers, charges for liquid fire extinguishers, boiler compound, hecktographs, electrolyte, polishes, inks, paints and disinfectants.

(Form B)

THE A. B. C. RAILROAD CO.

DEPARTMENT OF TESTS

Material Inspectors' Daily Report

.....191

Engineer of Tests:—

I have today made inspection of.....

.....

at the works of.....

.....

Have accepted.....

Have rejected.....

Inspected to date.....

Rejected to date.....

Accepted to date.....

There is a balance of.....due on this order.

.....Inspector

Order No.....

The question of policy places certain limitations on the manufacture of material by the railroad. In many cases economy might result should the company manufacture an article which is made by factories on the line of road but in

(Form C)

THE A. B. C. RAILROAD CO.

DEPARTMENT OF TESTS

Construction Inspectors' Daily Report

.....Works 191

Engineer of Tests:—

I have today found it necessary to request correction of work or material in order to comply with specifications and drawings as follows*

.....

.....

Order No.....Inspector

*If necessary to request change more than once, note beside item (2) for twice, (3) for third time, etc.

Loco's.

..... delivered today.

Cars

.....Delivered to date.

.....To be delivered.

NOTE:—If there is not sufficient space on this form attach letters.

such cases it is invariably better policy and better business judgment to patronize the home company rather than compete with it.

In order systematically to handle and record the work of the department blank forms are used to cover each and every procedure. Forms, with which all are acquainted, covering tests on axles, bar iron, boiler plate, springs, cements, etc., require no explanation, but special forms found to be of great value in the work of the department, may be of some interest.

Form (A) as shown, covers the inspection, test and chemical analysis of bridge material at the rolling mill. Three copies of this report are filled out by the inspector, and two of these copies sent to the engineer of tests. After check and approval one of these copies is sent to the engineer of bridges or any other official interested.

Form (B), material inspector's daily report, is a general form to cover the day's work of the material inspector and should be made out in addition to the test reports. It may be filed separately and makes a ready reference for tracing progress towards completion of an order for any material, also as a ready reference for locating at what place any certain inspector may have been at any specified time. It is imperative that this report shall be sent in daily regardless of whether any work has been done by the inspector that day. In this way close check is kept on the men where otherwise a week or more might slip by and the fact be overlooked that an inspector was idle on account of some delay at the mill or for some other reason not chargeable to the inspector. Oftentimes this regular report has enabled the chief inspector temporarily to shift his men about and accomplish a larger amount of work than would be possible if it were left wholly to the inspector to voluntarily write a letter regarding the situation.

Form (C), construction inspector's daily report, covers the same ground in the case of inspectors located at the shops in charge of the construction of equipment. A daily report should be demanded even if the shops are closed and the fact that the shops were closed and reason therefor should be stated as well as an estimate as to length of time the shops would be closed, etc. In the lower left hand corner of this report is the daily report giving status of the order in hand which information is very valuable for quick reference.

(Form D)

THE A. B. C. RAILROAD CO.

DEPARTMENT OF TESTS

Tie and Timber Inspectors' Daily Report

....191

Engineer of Tests:—

Inspected yesterday for.....at.....

First Class Ties.....shipped to.....

Second Class Ties..... " .....

Timber..... " .....

Rejected.....

.....

Will inspect to-day for.....at.....

.....

Will inspect tomorrow for.....at.....

.....

.....

NOTE:—Give any information that will be of interest to the Company.

.....

Order No.....Inspector

(Form E)

THE A. B. C. RAILROAD CO.

DEPARTMENT OF TESTS

Fuel Inspector's Daily Report

....191

Engineer of Tests:—

I have today inspected the following coal:—

PORT	BOAT	SHIPPER	REMARKS

..... Fuel Inspector

Form (D), tie and timber inspector's daily report, shows briefly the work accomplished during the day previous to receipt of the report at the office, what work is to be handled the present day and what will be handled the following day. The ground covered by the tie and timber inspectors is so extensive that it is difficult to keep proper record of the location of the men. The use of this form has accomplished this purpose and after filing the reports of each inspector under his own name, we have a complete diary covering his movements and work done. The relative value of the various inspectors can be easily determined by referring to these files.

Form (E), fuel inspector's daily report, keeps close check on the loading of boats at the coal piers and is a permanent record of the inspection of all cargoes inspected. It is also a check on the movements of the inspector without which it would be practically impossible to locate him. This report covers the inspection of all tide water coal taken up the sound and loaded at New York loading piers or at Philadelphia, Newport News or Norfolk. Later when the coal has been unloaded and used on the locomotives and complaints are entered, reference is made to these reports and if the criticisms of the fuel inspector agree with the complaints from the operating department a further reference is made to analyses

(Form F)

THE A. B. C. RAILROAD CO.

DEPARTMENT OF TESTS

General Foreman's Daily Report

.....191

Engineer of Tests:—

Inspected Yesterday at .....

Remarks.....

.....

.....

Will Inspect today at.....

Remarks.....

.....

.....

Will inspect tomorrow at.....

Remarks.....

.....

.....

.....General Foreman

(Form G)

THE A. B. C. RAILROAD CO.

DEPARTMENT OF TESTS

Report of Riding Engines

Division.....Date.....

Train.....

Engine.....

Engineer.....

Fireman.....

Left.....

Arrived at.....

Remarks.....

.....

.....

Signature.....

of samples sent to the laboratory by the fuel inspector which samples he has taken at the piers whenever the coal in his opinion has appeared especially bad. Should the analysis corroborate the inspector's reports and operating department complaints, the shippers would be called to account and some adjustment made in the settlement of the bill. All shipments of poor coal may not be discovered in this way but the moral effect on the shippers is of great value as they are not sure that any cargo will get by without rigid inspection and test.

(Form H)

THE A. B. C. RAILROAD CO.

DEPARTMENT OF TESTS

Lab. No..... Received.....

Directions for collecting and forwarding samples of coal for analysis.

The quantity for test should contain at least five pounds, which is to be sampled as follows —

1 Collect about fifteen pound portions of coal from various parts of the shipment until a mixed sample of at least one hundred and fifty pounds is obtained.

2 Break the lumps to a uniform size and thoroughly mix the collected portions and divide the pile in four (4) portions.

3 Treat one of the above portions in a similar manner by crushing and thoroughly mixing and again quarter.

4 Repeat this process again and then from one quarter take about a five pound sample for analysis.

5 Carefully fill in all the information required below, enclose same in an envelope and securely attach to sample, which is then forwarded at once to the Laboratory at New York, N. Y.

6 This blank should always be attached to the sample in order that the coal may be promptly identified upon arrival at the Laboratory.

Date.....Town.....State.....

Sample taken from (mine, car or barge).....

Coal is to be used at.....

Sample collected by.....Address.....

Brand.....Furnished by.....

Remarks.....

.....

.....

Sample forwarded by.....

Form (F), general foreman's daily report. The general foreman of the testing department has general oversight of all fuel stations—checking the accuracy of the fuel accounts and educating the various fuel keepers in making accurate estimates of the amount of coal issued daily to the locomotives in cases where it is not practicable to weigh the coal. In order to have permanent record of his work he has daily to make report as to what he did the day before, what he intends to do today and where he can be found tomorrow. Space is allowed on the form in each case to specify what was or is to be accomplished. The general foreman also acts as a fuel inspector to cover inspection at the time the coal is being discharged, or is in the coal bin or while it is actually being used on the locomotives or at the power plant.

Form (G), report of riding engines, is used by the general foreman or any other representative of the testing department when he rides an engine. Engines are ridden generally for the purpose of observing the use of coal, method of firing or to determine whether a delay which has recently been charged to poor coal was actually caused by poor coal or by the poor con-

(Form I)

THE A. B. C. RAILROAD CO.

.....191

To Engineer of Tests,

I send you herewith sample of Portland Cement

received at.....Car No.....

from.....

brand.....for use in.....

by.....

(This company or contractor.)

Sample collected by.....

Engineer in charge of work.....

.....

DO NOT FILL THESE BLANKS

Lab. No.....Rec'd.....Tested.....

Accepted.....Rejected.....

Remarks.....

.....

.....

(Form J)

THE A. B. C. RAILROAD CO.

DEPARTMENT OF TESTS

Information concerning Water Sent for Analysis

Sample from.....Station.....State.....Division

Sample taken by.....Date.....191..

1 Source of supply. (Well, creek, river, canal, pond, lake, spring, etc., giving proper name if it has any, and distance from tank).....

2 State if water changes in appearance at different seasons or after violent storms, due to greater or less amounts of sediment held in suspension.....

3 State if sample sent presents usual appearance of the water or whether it has been affected by recent storms.....

4 If from well, give diameter, (.....ft.); depth, (.....ft.). State character of soil sub-soil, and water-bearing stratum into which well is sunk.....

5 State distance of well from possible sources of pollution and their nature, such as cesspools, sewers, privies, stables, stockyards, slaughtering houses, rendering establishments, tanneries, distilleries, fertilizer manufactories, gas, glue, soap or bleaching works.....

6 If from running streams, state if it is subject to pollution above the source of supply, and if so how far up stream, and of what nature. (See 5).....

7 If from lake or pond, state character of drainage it receives. (See 5).....

8 If from spring, state nature of rock, if any, and of soil in the vicinity.....

9 State average consumption in gallons per 24 hours.....

10 State as near as possible the supply in gallons per 24 hours.....

11 Is this water for locomotive use?.....

Add such other information as will, in your judgement, assist in forming a correct idea of the character and source of the sample submitted.....

SAMPLING WATER FOR ANALYSIS.—For a technical analysis, such as a boiler water, one gallon will be required. For a sanitary analysis, at least three gallons should be sent. In the case of water suspected to contain poisons, or in other special cases, always confer with the Engineer of Tests before sending sample. The vessels must be new glass demijohns, or, if these cannot be obtained, jugs. Suitable vessels will be sent upon application.

FILLING THE VESSEL.—If the water is drawn by means of a pump, or from a tap, at least four gallons should be pumped or drawn off before filling the vessel.

In taking a sample from a creek, river, pond, lake or open source of supply, dip the vessel below the surface of the water, being careful not to disturb the sediment at the bottom.

Wash the vessel to contain the sample several times with the water to be examined, making sure that no dust or straw used in packing is left adhering to the sides. Finally fill with the water sampled, as above directed, leaving a little space unfilled to permit expansion by increase of temperature. Wash the cork thoroughly and rinse with the water in question. Stopper the vessels securely, always using **CORK** stoppers. **DO NOT USE SEALING WAX.**

In cold weather care must be taken to prevent freezing.

No analysis will be reported unless this blank is filled out, enclosed in tag envelope, form No. L 98, and attached to vessel containing water.

JOHN JONES,
Engineer of Tests

(Form K)

THE A. B. C. RAILROAD CO.

STORES DEPARTMENT

Laboratory No..... Req. No.....
P. A. No.....
.....191

Engineer of Tests,
Dear Sir:—
Sample herewith represents the following lot of material:
Amount and kind.....
Date received.....
From whom received.....
Ordered to Specification No.....
Please report results of tests promptly to .
.....Storekeeper
.....
.....
The above material has been tested and is.....
.....
.....
.....
.....191 .....Engineer of Tests

dition of the engines—lack of a brick arch or to the work of a poor fireman. Delays chargeable to poor coal are carefully investigated and a permanent and uniform report of riding engines was found necessary.

Form (H), this form is to be used whenever and by whomever samples of coal are sent to the laboratory from mines, boats, cars, bins, locomotives, tanks or power houses. It gives

(Form M)

Received ..... Pile No.....
Entered ..... No.....
CORRECT.

.....
Purchasing Agent.

THE A. B. C. RAILROAD CO.

DEPARTMENT OF TESTS

Certificate of Ties Accepted From

Full Name.....of P. O. Address.....
.....First-Class at..... Delivered at
.....Second " " ..... Division
.....
.....
.....
Rejected.....
Inspected.....191 .....Tie Inspector
Approved.....191 .....Engineer of Tests

(Form L)

THE A. B. C. RAILROAD CO.

Office of Engineer of Tests

.....191

Sample of.....

Received from.....this date

For future reference refer to Laboratory No.....

.....

.....

.....Engineer of Tests

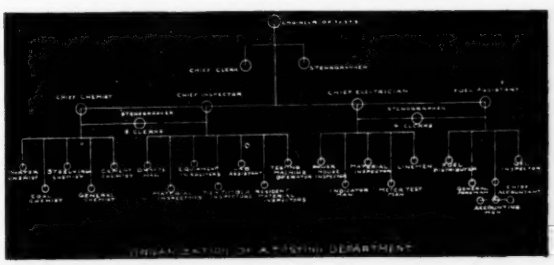
complete information necessary to identify the shipment and prevents confusion at the laboratory. The form after being filled out is enclosed in a tag envelope and tied to the canvas bag containing the sample. As is well known the value of a coal analysis is limited to the care taken in selecting the sample. This form contains detailed instructions regarding the selection of coal samples. It is necessary to issue these instructions for the reason that chief engineers are frequently leaving the service and new ones employed.

Form (I). When cement samples are submitted this form accompanies the sample to the laboratory and furnishes necessary identification. After tests have been completed the lower blanks are filled in by the chemist and the form returned to the party submitting the sample or filed away in the laboratory and report sent by letter.

Form (J) Representative samples of water are as difficult to secure as are correct coal samples and on this account a form should be prepared which combines instructions regarding selection of sample as well as the necessary information to secure its identification at the laboratory. Samples of water are examined and analyzed for reasons as follows:

(a) New water supply is desired for power plant.
(b) Boiler troubles are experienced in case of stationary plants or locomotives.
(c) Contamination with sewage or roundhouse waste.
(d) Drinking water (purity of).

Form (K). This form is a stores department form used when transmitting a sample of material to the laboratory for test. It is not practicable to hold up the use of material to await the results of the laboratory analyses and tests but check is made of the quality of the material shipped regularly to the company and should the tests fail or the specifications not be fulfilled the supply house may be called to account and immediate improvement in the quality will be the result. A second or third offence on the same defects means cancellation of contract or the entire elimination of that brand of material from the company's storehouse supply. It may be impossible actually to make tests and analyses of the samples taken from all the ship-



Plan 1.

ments to the several storehouses of the company, but as said before, the moral effect is half the battle. After tests or analyses have been made the results are recorded on the lower part of the form and it is returned to the storekeeper submitting the sample.

Form (L) is used in acknowledging the receipt at the laboratory of samples of material or articles to be tested. Laboratory numbers are assigned which facilitate correspondence on the subject and eliminate many chances for confusion of one sample with another.

Form (M) is used for each and every lot of cross-ties inspected. This form after passing through the office of the testing department is signed by the purchasing agent who checks the prices and is then forwarded to the auditing department to be vouchered.

Plan 1. Shows graphically the organization of the testing department. The relations of one member to another in the department will of course vary on different roads but the work of the department can be very successfully handled with the organization shown. To those officials or employees who have never visited the chemical and physical laboratories of a railroad an appeal is made to do so as soon as possible and there will be demonstrated to you the innumerable investigations on technical subjects which are pertinent to every branch of railroad work. You will be impressed with the value of this work and the secret will be revealed as to the lower percentage of operating cost of the progressive railroad over the old fashioned, super-conservative railroad.

COAL TAR—ITS PRODUCTS AND USES.*

By Mr. William W. Borman.

Prepared Under the Auspices of the International Lecture Institute.

Nature.

Coal tar is the product of the destructive distillation of bituminous coal. It is condensed from the vapors given off from such coal when it is heated in a closed vessel, or in a confined space, beyond the point of decomposition. So obtained, coal tar is a viscous, oily fluid, black or dark brown in color, having a specific gravity of 1.1 to 1.3, and it usually contains from 3 to 20% of water more or less intimately mixed with it. It is generally produced under two different conditions: First, during the destructive distillation of coal to produce illuminating gas in modern gas plants, and, second, in the large by-product coke oven plants which are operated for the purpose of producing coke, and in which operation coal tar is also a by-product, as well as coal gas and ammoniacal liquor.

Composition.

Coal tar, chemically considered, contains practically but four elements—carbon, hydrogen, oxygen and nitrogen. Small quantities of sulphur, chlorine, sodium, lime and other ash-forming elements occur incidentally. Coal tar is a complex and exacting material with which to work, owing to the fact that, although the four principal elements are always present, their proportions vary greatly, especially in the various forms in which they occur. This is due to differences in the coal from which the tar is distilled, as well as to variations of the distillation temperature and other causes. Under skilled chemists, coal tar yields products of surprising diversity, many of which are of great value, and each year some new use for the tar and its allied products is discovered.

In the destructive distillation of coal four products are obtained. These are gas for heating and illuminating purposes, coke for domestic and manufacturing purposes, raw coal tar and ammoniacal liquor, more generally known as ammonia water. In this paper I shall deal almost exclusively with the two latter products, coal tar and ammoniacal liquor.

The development of the coal tar industry in the United States has been along the lines best suited to the commercial conditions in this country, and these conditions differ greatly from those that obtain in England, France and Germany. A great demand for waterproofing and roofing materials has been here created on account of the vast building operations constantly going on. The commercial production of the higher coal tar derivatives has, on the other hand, been neglected, although there is a strong and ever increasing demand for the coal tar chemical products. The importations into the United States of alizarine, aniline salts, colors, dyes and other coal tar chemical products exceed in value seven million dollars annually.

Crude tar made at the different gas works or by-product coke ovens varies considerably in constitution. Indeed, the tar produced by the same oven may vary from time to time, as it is always a by-product and practically no effort is made towards uniformity of quality. The original form of bee-hive oven was patented in England as early as 1620. From its shape the origin of the name "bee-hive" is readily apparent. This oven is about 12 feet in diameter and approximately 6 feet high inside, and is built of fire brick and entirely enclosed except for an iron door frame in the side, which is built to hold a temporary brick wall, with which the opening is closed while in operation. The coal is charged into the oven through the top opening from a car running on tracks built above the oven. The heat remaining in the oven brickwork from the previous charges, or from preliminary heating, starts the evolution of gas, which is ignited and burns with the air entering in the opening at the top of the door. The combustion heats the arched dome of the oven, which reflects the heat to the coal charge below, causing it to become coke. When all the gas is burned off, the oven is opened and the coke quenched by throwing water into the oven from a hose.

A peculiar feature of this arch-type bee-hive oven is the fact that, the charge of the coke being withdrawn, the lower part of the door being immediately bricked up, and another charge of coal being put in, the heat remaining in the oven from the previous charge is sufficient to start distillation. In other words, after the oven has once become heated, it is not necessary to heat it again until it is desired to stop operations for coke. You will notice from the shape of this oven that all the gas passes off through the opening in the top and nothing is saved but coke; the tar, ammoniacal liquor and gas going off into the air as vapor.

The Modern By-Product Coke Oven.

Soon after 1894 the first by-product coke oven plant was built in this country at the works of the Cambria Steel Co. at Johnstown, Pa. It is in successful operation to-day, though more than quadrupled in size. These ovens are usually elevated for reasons which will be described later. The oven itself is about 33 feet long, 6½ feet high and from 17 to 22 inches in width, containing six to seven net tons of coal at a charge. The side walls are provided with vertical internal flues heated by gas, one flue serving for the near sides of two adjacent ovens. A sectional view of such a plant would show to the layman alternate rows of flues and ovens.

The ends of the ovens are closed by iron doors fitting close to the walls. The coal is charged into the ovens by a machine from above known as a "larry." This "larry" has spouts which deliver the coal through corresponding charging holes in the oven top to the coking chamber below. As the heat from the flues at the sides of the oven cokes the coal, the illuminating gases are carried off in one set of mains and

*Presented before the St. Louis Ry. Club by Prof. A. S. Langsdorf, School of Engineers, Washington University.

the vapors containing the tar and ammoniacal liquor pass off through flues for subsequent treatment.

After the coal is thoroughly coked, the iron doors at the ends of the ovens are raised and a pusher—a specially designed machine which is operated by electricity and which has a face the exact shape of the oven—is introduced into the oven, pushing the entire charge of coke out at the other end, where it falls onto a large steel platform. Here it is quenched, in some cases by water from a hose and in others by specially designed quenchers which flood the coke with a large volume of water, putting out the fire immediately. After the coke has been cooled sufficiently, the bottom of the steel platform is opened and the coke drops below into a railroad car, and is then ready for shipment.

In the production of coal tar, it passes from the retort into the hydraulic main and is there condensed in water, then a portion not condensed passes into the condensers, then some to the scrubbers and some even escapes these three. The tar, mixed with many impurities, is then drawn into what is called the well. From the well it is pumped into a tank, where there is a rough separation of the tar and the ammoniacal liquor. The temperature of distillation, the nature of the coal and the separation of the lightest oils all influence the product, and thus coal tar from gas works is a most variable substance.

The modern methods of treating coal tar, that have been developed from the crude beginnings we have spoken of, all include a certain amount of distillation. The tar is placed in a still, to which heat is applied, and the vapors driven off are cooled and recondensed. If the distillation is carried far enough to leave a residue that hardens in cooling, the oils so obtained may be roughly separated into those lighter than water and those heavier than water, the residue being termed pitch.

By closely observing the temperatures at which the oils are distilled off and separating those corresponding to certain ranges of temperatures a number of separate products are obtained. The primary ones that are subdivided for various purposes are as follows: Light oil; carbolic oil (for phinol and naphthalene); creosote oil; anthracene oil, and the residue—pitch.

Pitch can be made of any desired consistency or melting point—the greater the amount of oil removed the harder the resultant pitch. Of late years specifications are frequently drawn up requiring a pitch for roofing or waterproofing purposes of an exact melting point or consistency. In order to make pitch on specifications of this kind, it requires a man of long experience in distilling tar to produce the desired grade. The greatest demand in this country is for the softer pitch resulting when only a small portion of the anthracene is removed, although the harder is used to a limited extent.

Several years ago the demand for pitch in this country far exceeded the supply, and it was the custom to bring from abroad a pitch of a very hard nature, of high melting point, and to mix with it sufficient tars or oils to cut it back, or, in other words, to produce the exact consistency of pitch needed. This was a dangerous practice, as in making the hard pitch originally all the life-giving oils were removed and it has been found impossible to put back oils into pitch and make a "cut-back" pitch which would last for any length of time. To-day there is very little "cut-back" pitch made in the United States, most pitch being what is known as 'straight run," that is, distilled to the proper consistency, removing only such oils as are necessary to leave a pitch of the proper melting point.

In order that you may have some idea of the quantity of tar produced in the United States, I will say that there is manufactured in this country annually something over one hundred million gallons of coal tar. The quantities produced in different years, however, vary, being entirely governed by the demand for coke, gas, etc., but in one year recently the production exceeded all previous records by over twenty-five million gallons.

Many years ago, when the quantity of tar produced was small, the problem of transporting it was a comparatively simple one. To-day, with the vast amounts that have to be carried on water and land, there are employed hundreds of all-steel tank cars, holding approximately ten thousand gallons each, as well as many tank barges, holding from fifty thousand gallons to three hundred thousand gallons each. In some cases short pipe lines are used and the tar is pumped direct into tanks from gas works and coke oven plants.

Some of the Uses for Coal Tar.

Coal tar in its raw state has a wide variety of uses, among them being the coating of iron pipes for preservation against corrosion, the making of tar concrete sidewalks, which are used almost exclusively throughout New England and some other sections, and various other purposes which would not, probably, be interesting to you here.

Refined Tar.

Owing to the different methods used in producing tar, the crude tar at different plants has been found vastly different in consistency and composition. As before said, even at some one works the grade of tar will vary from day to day. For success in the use of tar, a uniform product is most important.

(To be continued.)

Consul-General S. S. Knabenshue, of Tientsin, China, under date of Sept. 5, 1910, states that the president of the Tongshan Engineering and Mining College is desirous of obtaining apprenticeships with American railway companies or railway-supply companies for graduates in the course of railway engineering offered by that college. This would enable the Chinese apprentices to become familiar with American railway materials, and would undoubtedly exert some influence in securing future Chinese orders for these materials.

Edward Laas, engineer maintenance of way of the Chicago, Milwaukee & St. Paul, resigned that position Nov. 1, to engage in private business. Mr. Laas has been connected with the road department of the C. M. & St. P. for more than 30 years.

R. G. Kenly, chief engineer of the Minneapolis & St. Louis and the Iowa Central, with office at Minneapolis, Minn., was born March 13, 1866, at Ritchie Mines, W. Va. He finished his education at Baltimore City College, and began railway work in September, 1885, as a rodman and levelman on surveys and location, with the Annapolis & Baltimore Short Line. He was promoted through the engineering department with different roads, and in 1891 became a supervisor of the Norfolk & Western; he was later assistant engineer and then assistant trainmaster of that road, and in 1898 was appointed assistant to the chief engineer of the West Virginia Central & Pittsburgh. The next year he went to the Pennsylvania as draftsman and engineer in charge of construction, and in 1900 became a supervisor, and then a division engineer on the Lehigh Valley. Four years later he was appointed a trainmaster, and in March, 1907, general superintendent of the Lehigh & New England, with jurisdiction over the operating, mechanical and engineering departments, and for six months from June, 1908, he was engineer of maintenance of way of the Lehigh Valley. He was then made chief engineer of the Minneapolis & St. Louis and the Iowa Central, and when those roads were consolidated with the Chicago & Alton and the Toledo, St. Louis & Western in November, 1909, he became engineer of maintenance of way; now that the managements are separated again, he has been reappointed chief engineer.

The Maintenance of Way Department

Work Preparing for Winter

Editor, Railway Engineering:

First. Everything possible with the force at hand should be done to have tracks in the best possible condition.

Second. All ditches should be cleaned out to afford the free passage of water. Ditches which cross at bridges and culverts should be opened and all obstruction should be removed to all on the free passage of water. All tile drains, and other drains, which lead away from switches, tracks, signals, buildings, etc., should be in proper working order.

Third. Track should be carefully examined, and where obstructions cannot be removed that would interfere with the working of snow plows and flangers, markers should be installed. All snow plows and flangers should be carefully inspected and tested and the necessary supply of tools supplied and carefully placed and locked in each car.

Fourth. Provisions should be made for tools and supplies necessary for taking care of ice and snow during winter, as the demands may require, and at points where conditions are liable to require that such tools and material would be necessary.

Fifth. Rail supply for repairs should be placed at intervals and in convenient places along the track and should be set on rail rests, which keep the rails two feet above the ground. They should be placed opposite mile posts so that they may be easily found and conveniently located when large quantities of snow may be laying on the ground.

Sixth. All scrap iron, scrap rails, and in fact scrap of every description should be picked up and shipped to headquarters. All material should be carefully picked up and piled in convenient places where it can be found readily and without loss of time.

Ontario. Roadmaster.

Editor, Railway Engineering:

In regard to preparation for winter by section force, there are so many things necessary to be done in this climate that I hardly know which is the most important; in fact, our entire summer work is really getting the track ready for winter. I consider about the most important matter to have the track in good surface and line so that when the ground freezes the track will ride smoothly, otherwise it must be rough the entire winter. The last things we usually do are to clean out our ditches in good shape and put up snow plow markers. In very snowy parts of the system poles are put up at the ends of culverts so that they can be located during the winter and opened up should a thaw be imminent. There are many other incidentals to be looked after; namely, to have sections properly supplied with salt, snow shovels, shimming material and the like, which are always used during the winter months.

Massachusetts. Roadmaster.

Editor, Railway Engineering:

Assuming that all tracks have been thoroughly gone over during the summer months and that surface and level is perfect to go into the winter; the most important work for section forces to do is to clean out all ditches and drains effecting track or right of way, repair all stationary snow fences, repair and put in place all portable snow fences and see that all crossing planks are securely spiked down; that snow plow and flanger markers are erected to protect everything liable to be struck by plow or flangers and that all planks are removed from private crossings that will not be needed during the winter months.

Much attention should also be given to digging out from under spring frogs, switch points and under the rail the full length of track circuits where such are in use. Foreman should also be instructed to canvas his territory to know where he can get extra men in case of snow storms and have arrangements made with some restaurant to furnish food on short notice for extra men when their services are required. Where section gangs have been reduced to a winter basis this usually occupies all of their time from the date they finish up general track work until winter sets in in earnest and when ice and snow gets in frogs and switches and at crossings it keeps them busy with oftentimes the necessity of extra help to keep traffic going.

New York. Supervisor of Tracks.

Editor, Railway Engineering:

There are several classes of work that section forces should do in preparation for winter. Get their ditching all done, all vegetation removed from intake end of pipe culverts, embankments widened, all track put to good surface and line, right of way fence put in good repair, all material gathered and neatly piled and shipped to store house if a surplus. Scrap should all be collected and shipped in. All side tracks should be cleaned up and all vegetation should be cleaned from buildings and bridges, station grounds cleaned up and everything pertaining to the betterment of the railroad should be done before our heavy winter sets in.

Oklahoma. Roadmaster.

Editor, Railway Engineering:

In preparing for winter we dig out material from between ties before the ground becomes frozen under switch points, spring rail frogs, etc., bank all buildings, water tanks, etc., see that spikes are driven home to rail and bolts tightened. We also do some of what we term summer shimming by digging down ties where we know track is going to heave before ground is frozen, placing shims on ties and removing as track heaves. This keeps track safer and requires less shimming. We also place brush at ends of drain tile to prevent water passing out from freezing and do the same thing where springs exist, the water of which has to be carried in our track ditches. By so doing, after snow falls we prevent water from freezing, thereby saving a good deal of trouble from track heaving, besides the labor of having to pick and remove ice. We also take pains to have all our snow fighting equipment in readiness, snow plows, flangers, etc. It is also essential to see that ample shims of proper size, braces and shimming spikes are provided and that everything is removed from right of way that is possible, such as weeds, grass, etc., that would be apt to cause a snow drift.

Massachusetts. Roadmaster.

Killing Weeds.

Editor Railway Engineering:

I wish I knew of a good way of killing weeds, besides pulling them up. Supervisor.

Pennsylvania.

Editor Railway Engineering:

We cut our right of way twice a year, mostly with machine. This kills the weeds. Roadmaster.

Indiana.

Editor Railway Engineering:

In regard to best method of killing weeds on right of way, this should be treated as two separate subjects, the weeds which grow in the track being treated as one and those which

grow outside the weed line, as another. The ones inside the track, we have always destroyed by cutting, either with shovel or hoe. We find no other way of keeping them down in certain kinds of ballast. In fact, they will grow in most any ballast, except crushed stone or cinders. On portions of the road bed which we have oiled, we have little trouble until the strength of the oil is gone, which generally takes two years, after which they will begin to come up again. The weeds outside the weed line we pay no attention to, except once a year, when we cut them, together with grass and bushes with scythe. This is generally done between the middle of July and the middle of August, varying our time, somewhat, on different portions of the road, account of vegetation being further advanced in the south and lower portions than in the north and higher altitudes. Roadmaster.

Massachusetts.

Editor Railway Engineering:

I have never worked for any company that made an effort to kill weeds on right of way. We use weed-burners for destroying or removing weeds on tracks. They, as you no doubt are aware, consist of something on the order of an ash pan or under-flat car, or extend on rear of tender of engines with a lot of jets, from which crude oil passes and, when ignited, burns weeds. We, of course, are compelled by law to destroy all noxious weeds on right of way, which is done by pulling out by roots and burning. Aside from that, we simply cut with scythes or mowers, where latter can be used, the latter part of each July or August and then burn.

Wisconsin. Roadmaster.

Editor Railway Engineering:

My experience with the best methods of eliminating weeds from the right of way is to plant Bermuda grass. I have watched this closely in the past ten years, and find that weeds are very scarce where Bermuda grass grows. This is not a very expensive undertaking, as it can be done as cheaply as the right of way can be cleaned in one year, and it also protects banks from cutting and sluffing off.

Texas. General Roadmaster.

Editor Railway Engineering:

My method of killing weeds on right of way is to cut in June and August between 1st and 15th. After the August cutting burn right of way. The burning does not injure blue grass. If this method is followed each year the right of way will soon become covered with good set blue grass and look fine.

Indiana. Supervisor.

About 50 railway officers went to Urbana, Ill., November 7, in a special train provided by Vice-President Park, of the Illinois Central, and were shown over the University of Illinois. The trip was made to see the work being done for the benefit of railways by the university. A meeting in the afternoon was addressed by President James, Deans Goss and Kinley, Professors Schmit and Stoek telling of university railway work. D. C. Buell read a paper describing the educational work of the Union Pacific. President Delano, of the Wabash, also gave a talk. On motion of W. L. Park, seconded by Vice-President Aishton, of the Chicago & North Western, a resolution was adopted pledging the support of the Illinois raliways to the university in its effort to get the Illinois legislature to make adequate appropriation for enlarging the university's railway work. Almost all railways in Illinois were represented by one or more officers designated by their presidents. The trip was organized by Mr. Delano.

Construction.

The extension of the Hudson & Manhattan Tunnel railway northward from Twenty-third street to Thirty-third street, New York City, was put in operation November 10. A special train with a party of guests was run over the line last week. On the extension farther northward from Forty-second street and thence eastward to the Grand Central Terminal construction is to be begun next spring.

Rapid progress is being made in constructing the Soo line cutoff between Withrow in Washington county and New Richmond, Wis. The grading is nearly completed between Withrow and the St. Croix river and is finished between the river and New Richmond. Track is being laid between New Richmond and the St. Croix. A track laying machine is in use and about two miles daily are being put down. The piers for a concrete bridge over the St. Croix, to take the place of the old Soo bridge and the Wisconsin Central bridge, have been built.

Construction of the Fargo to Minot cutoff of the Great Northern is to be resumed early next year, according to President Louis Hill. He says that there is no foundation for the report that the work is to be abandoned, but that as early as it is possible to do so, the work will be resumed next spring.

The Burlington has completed the purchase of the last piece of right-of-way, over which will be built its proposed line from Hudson, twenty-nine miles east of Denver, on the Denver-Chicago line, to Greeley. While no definite announcement of the date of beginning work on the new line has been made, railroad men anticipate that it will be built at once. It is understood that certain members of the Burlington directorate are insistent upon the immediate construction of the line, while others argue that if it is built in the spring, it would still be in time to move the 1911 crops raised tributary to the right of way.

The Northwestern Pacific has awarded a contract to the Utah Construction Co., Ogden, Utah, for the construction of thirty-one miles of track between Willets and Shively on the road to Eureka, Cal.

The Stearns and Culver Lumber Co., Bagdad, Fla., has awarded a contract for grading and laying track on ten miles of the Florida & Alabama Railway to J. N. Gillis & Son, Brewton, Ala.

The Chicago, Memphis & Gulf has awarded a contract to W. L. Mozley, Memphis, Tenn., and C. T. Bondurant, Hickman, Ky., for grading its line from a point ten miles out of Hickman into that city.

The Mexico, Farwell & Southern has awarded a contract to the Calback Construction Co., Portland, Ore., to build about one hundred miles of new line from Texico, N. M., and Farwell south.

The American Bridge Co., New York, N. Y., has secured a contract at $125,428 for iron work for the elevated construction of the Port Richmond branch of the Philadelphia & Reading.

The Harriman, Knoxville & Eastern has let a contract to McDowell Construction Co., Knoxville, Tenn., to grade the first seventeen miles of its proposed line.

The Nuces River Valley railroad has let contracts for its extension from Beeville to Eagle Pass, Texas, 180 miles.

A contract has been awarded to Bunn & Co., Big Stone Gap, Virginia, for the construction of five miles of railroad up Roaring Fork, from a point near Appalachia, Virginia, on the Interstate railroad.

The Baltimore & Ohio has awarded a contract to Bennett & Talbott, Fairmont, W. Va., to build four additional freight tracks at Clarksburg.

The Superior & Southeastern has awarded a contract to

Balch & Co., Rice Lake, Wis., to build a ten-mile extension from Grandview, Wis.

The Kettle Valley will be the scene of great railroad construction activity this winter. The contractors in charge of the construction work on the Kettle Valley railroad will have 400 men in the field.

Work on the Atlantic North & South, in Iowa, is being pushed with vigor and the grade will soon be finished. The road will be completed on contract time. It is said that the first shipment of rails will arrive at Atlantic soon and the work of laying them will begin at that end of the road. The grading work in the vicinity of Grant and Sciola is about completed. Some 200 teams are at work along the line.

Active work on the construction of the Birmingham, Demopolis and Pascagoula, between Demopolis, Ala., and Linden, Ala., is expected to begin shortly.

The tunnel 5,425 feet long under the peninsula at Portland, Ore., for the Oregon & Washington, has been completed. The work has been in progress since August of last year, and will represent an investment of $1,000,000. It will shorten the route of the railroad five miles between Portland and Vancouver. The tunnel will not be ready for operation until next March.

C. F. Betz, a railroad contractor of Sioux City, with a crew of about fifteen men and twenty teams, together with a large amount of grading machinery, is engaged in filling in a big trestle of the C. M. & St. P. near Washington Mills, Iowa.

It is reported that preliminary work is to be immediately begun on the construction of the Libby-Kalispell cutoff of the Great Northern, up Sun river from Great Falls, Mont., about 100 miles. This will put Kalispell back on the main line of the Great Northern, and shorten the distance between the two places named about thirty miles, while at the same time tapping one of the richest parts of Montana.

The C. M. & St. P. road will build a line from the terminus of its present branch at Hutchinson, Minn., through Stearns, Douglas, Otter Tail and Clay counties, work to be begun in early spring. The destination of the road is Winnipeg and work will be continued to that point from the new extension.

The Toronto Construction Co., the sub-contractors for the Grand Trunk Pacific, building ninety-seven miles of the main line east from Monoton, have their part of the work well under way and will finish soon. The first fifty miles east of Monoton has been complete and the rail laid.

With twenty-three miles of grading done and track laying about to begin, it is expected that the San Antonio, Rio Grande & Tampico will be completed between San Antonio and Jourdantoro, Tex., by the end of this year. It has been surveyed for more than 100 miles.

General Manager Charles H. Hix, of the Seaboard Air Line, in an interview in Birmingham, Ala., announced that his road would soon begin work on the extension of its line from Jacksonville, Fla., to Anniston, Ala., a project which has been under consideration for several years. Under the company's extended franchise in Anniston, it will forfeit $25,000 unless the work is begun by January 1.

Kaiser & Maloney, railroad contractors, now at Stuttgart, Ark., have finished 10 miles of the Central Arkansas & Eastern. They are now ready to take a new contract requiring machine work. They have a 42-team outfit ready for this work.

The 600 miles of the Pacific Electric Railway, together with the power plants, cars and other equipment, has formally passed into the control of the Southern Pacific. The transaction precedes the retirement of H. E. Huntington, who began in 1900 the development of what is now the largest system of interurban railways in this country. This gives the Southern Pacific control of nearly all of the interurban lines centering in Los Angeles, approximately 700 miles.

Good progress is being made by the Canadian Northern in the work of constructing a new road between Virginia and Duluth. Contractor Jacobson has the Eleventh part of the work well along. Night and day crews are being worked by several of the sub-contractors, and every effort made to push the work to a rapid completion.

The Philadelphia & Reading has awarded contract No. 22 for track elevation on its Richmond branch between Somerset and Trenton avenue, to John McMenany, 401 Hornson Bldg., Philadelphia, for $117,426.

The Norfolk & Western has awarded contracts for the construction of 11¼ miles of track to be known as the Cedar Bluff extension. Rinehart & Dennis Co., Washington, D. C., two miles; Walton & Co., Falls Mills, Va., 2½ miles; W. O. Lipscomb, Roanoke, Va., two miles; A. H. Valz, Staunton, Va., two miles; P. J. Millett, Paris, Ky., 2¾ miles. Another extension, known as the North Fork branch, to consist of four miles, was awarded as follows: Vaughan Construction Co., Roanoke, two miles; Carpenter & Boxley, Roanoke, two miles. The cost will be about $1,500,000, and work will be started at once on all the contracts.

The Lehigh Valley has let a contract for the double tracking of a section of its line in the anthracite coal region of Pennsylvania. The line, which has an importance out of all proportion to its length of 6.2 miles, because it is what is known in railroading science as the "neck to the bottle," runs from Laurel Junction to Silver Brook Junction, and will, upon the completion of the Hays Creek branch next year, accommodate a heavy coal traffic. The new construction will be done within six months.

The C. I. & S. is building a concrete pile and slab trestle over the Kankakee river at Shelby, Ind. The bridge is to be 1,240 feet in length. The trestle piles are made by the American Concrete Co., by the Chenowith process.

The new stretch of double track which the Baltimore & Ohio is building on the Chicago division between Wellsboro and McCoole, Ohio, a distance of twenty-one miles, will be completed and placed in service on January 1. Construction work on the new track was begun some months ago, and is now being rushed to completion. The improvement will represent a cost of nearly $1,000,000.

The Chicago, Indiana & Southern is double tracking its line between Indiana Harbor and Danville, Ill., forty-five miles already being completed.

The Louisville & Eastern has awarded a contract to M. Casey of Birmingham, Ala., for building nine miles of road on the extension from Jackson to Whitesburg, Ky.

The Grand River, Meeker & Salt Lake, which was recently incorporated, to build a line three hundred miles long from Chapman, Colorado, toward Salt Lake City, Utah, has awarded a contract to the Meeker-Rangely Construction Co., Denver, Colo.

The Lexington & Eastern has awarded a contract to Winston & Co., Richmond, Va., for extending its road twelve miles, from a point three miles above Whitesburg, Ky., to and up Boone's Fork. This makes the extension from Jackson, Ky., 100 miles long.

The North Carolina & Virginia has awarded a contract to the Luck Construction Co., Roanoke, Va., for building twelve miles of road from Spray to Ridgeway, Va. Marshall Field & Company, of Chicago, owners of mills at Spray, are said to be backing the road.

The Erie has awarded contracts for double tracking the line between Sherman and Rittman, Ohio, nine miles, to James A. Hart Co., 256 Broadway, New York, and between Rittman and Sterling, four miles, to Ferguson & Edmondson Co., Brookville, Pa. The Erie also contemplates double track-

ing the line between Ravenna and Freedom, Ohio, six miles, and a short piece of track near Kent, Ohio.

J. R. McDowell, who was awarded the contract for seventeen and one-half miles of construction on the Harriman, Knoxville & Eastern, has awarded sub-contracts to the F. W. Hunt Contracting Co., and the Cross Construction Co., A. G. F. Fretwell, M. M. Schultz, George L. Davidson and Eddington and Pack.

The contract was awarded to McDowell and Co., Knoxville, Tenn., for the construction of a new road from Harriman to Oliver Springs, a distance of about seventeen and one-half miles, at a cost of about $500,000. The Louisville & Nashville is interested in this line.

Octave Chanute died on November 23 at his home in Chicago. Mr. Chanute was seriously ill of pneumonia in Europe last summer but recovered sufficiently to come home in October. He was born in Paris in 1832 and was brought to this country as a child. He began work in 1849 on the construction of the Hudson River railroad. After four years on this road, he was on construction work on part of the Chicago & Alton. In 1854 he was made chief engineer of the eastern part of the Toledo, Peoria & Warsaw. After he built this he remained in charge of maintenance of way until 1861, when he went to the Pittsburg, Fort Wayne & Chicago as division engineer. A year later he was made chief engineer of maintenance of way of the Western division of the Ohio & Mississippi, and in 1863 went to the Chicago & Alton as chief engineer. Four years later he was made chief engineer in charge of the construction of the Missouri river bridge at Kansas City, having, while still on the Alton, won a prize for a design for a bridge across the Missouri at St. Charles, Mo., and also made a design for the Union Stock Yards at Chicago. While he was building the Kansas City bridge he was made also chief engineer of the Kansas City, Fort Scott & Gulf, and later put in charge of the building of several other roads in Kansas. He also designed and built the union stock yards at Kansas City. In 1871 he was made general superintendent of the Leavenworth, Lawrence & Galveston, and in 1873 went to the Erie as chief engineer. During his ten years' service on the Erie he put through important improvements, including double-tracking, grade revision, and making the road standard gauge. He was made assistant general superintendent in 1875. In 1884 he opened an office as consulting engineer at Kansas City, and during the next few years was in charge of construction of certain bridges on the Chicago, Burlington & Northwestern and the Atchison, Topeka & Santa Fe, including the one over the Mississippi at Ft. Madison, Iowa, and the one over the Missouri at Sibley, Mo., being consulting engineer for the latter. In 1885 he organized the Chicago Tie Preserving Co., using zinc chloride. This company, which has been succeeded by the firm of O. Chanute & Co., later took up also zinc-tannin, zinc-creosote and other processes.

Mr. Chanute became a member of the American Society of Civil Engineers in 1868. He was vice-president in 1880 and president in 1891. He was president of the Western Society of Engineers in 1901, and at the time of his death was an honorary member of that soicety, as well as of the Institution of Civil Engineers (Great Britain), the Society of Civil Engineers (France) and the Chilean Society of Engineers. He was a member of the Candian Society of Civil Engineers, the American Institute of Mining Engineers, the American Railway Engineering and Maintenance of Way Association and a number of aeronautical societies. He leaves a son and three daughters.

The Signal Department

RAILWAY SIGNAL STANDARDS NO. 13. THE PENNSYLVANIA RAILROAD.

The majority of signals on this road operate in the lower right round quadrant and are the two position type. The Pennsylvania, however, was one of the pioneers in the use of three position upper quadrant signals and they have a large number in service; they are using nothing else for new work. The lower quadrant signals have a stroke of 75 degrees, upper quadrant, 90 degrees. Night color indications are white for clear, green for caution and red for stop. The aspects for the three position upper quadrant signals are in accordance with the recommendations of Committee No. 1 of the Railway Signal Association. All automatic block signals stand normally at clear, and mechanisms are at the base of post.

Fig. 284 shows the upper quadrant blade, and Fig. 285, the two blades, home and distant, used for lower quadrant signals. All blades are painted yellow with a black stripe. Corrugated iron blades, enameled, are also used. Fig. 286 shows the cast iron bolt plate used over the end of the blade where it is fastened to the blade grip. Spectacles in future will be R. S. A. standard.

Signals are of both the electro-pneumatic and electric motor types. They are operated by caustic soda, potash, gravity and storage battery. Battery is housed in wooden wells, wooden boxes, and cases at base of signal, according to circumstances. Track battery is either 2 to 4 cells of gravity, or 1 cell of storage. Gravity track battery is housed in cast iron chutes similar to that shown in Fig. 47. The Standard gravity battery zinc is shown in Fig. 306. The same battery is used for line control and signal operation if necessary. Polarized track circuits are, however, extensively used.

Storage battery is charged either from line or third rail. The portable type is not used.

On the electrified lines, of course, a. c. track circuits (Fig. 322) are employed. The traction current is at a pressure of 550 volts d. c. All track circuits average 4,000 ft. in length. A. C. track circuits take current at a pressure of 10 volts, 25 cycles. The mains have a pressure of 2,200 volts and 1,100 volts 25 cycles. A. C. control circuits are at a pressure of

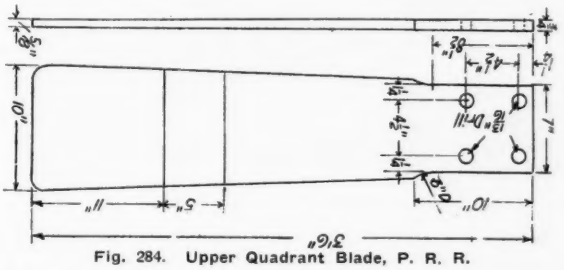


Fig. 284. Upper Quadrant Blade, P. R. R.

110 volts 25 cycles. Iron core inductive bonds (Figs. 323, 324) are used with a. c. track circuits. Fig. 325 shows method of supporting transformers. A separate pole line for signal wires is not used. Common return is broken occasionally. Fig. 305 shows cable supports.

Wire ducts are run both above and below ground. They consist of wooden trunking and tapping, Fig. 287. Figs. 288, 289, show the wooden bootleg and method of connecting wire to rail. Fig. 290 is a trunking layout.

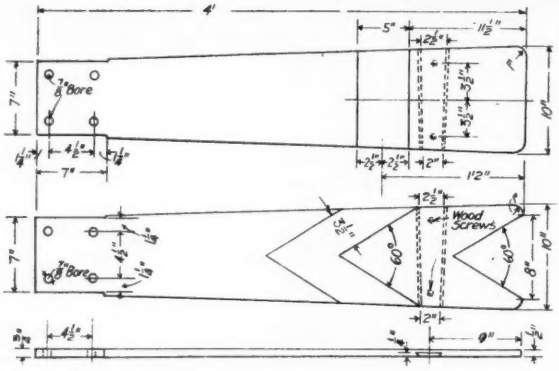


Fig. 285. Lower Quadrant Blade, P. R. R.

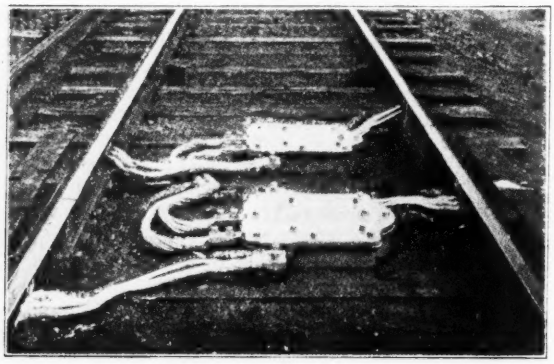


Fig. 323. Inductive Bond with Triple Connections to Each Rail, P. R. R.

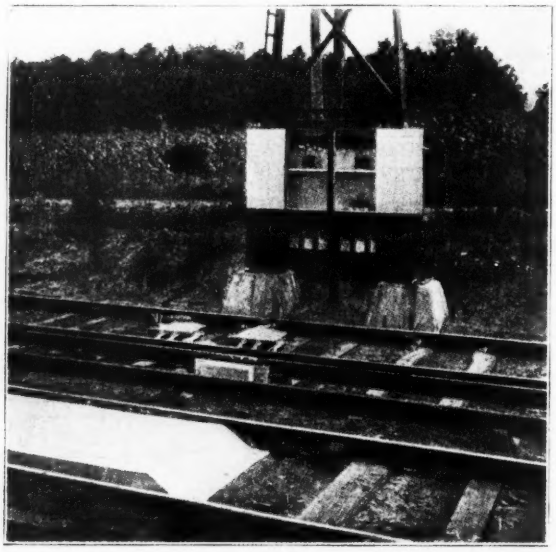


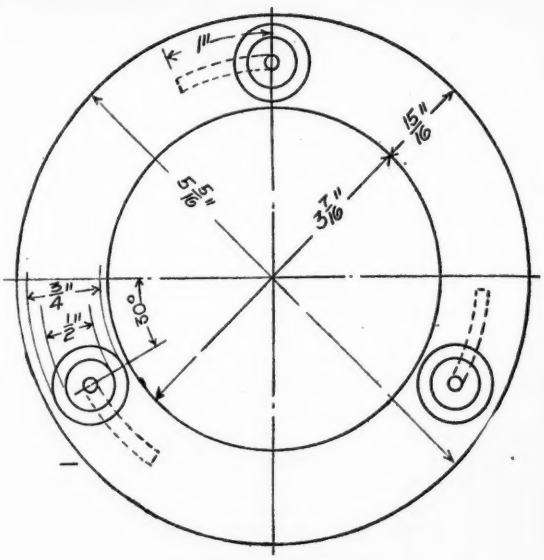
Fig. 324. Inductive Bonds, Covered and Exposed, P. R. R.

Overlaps and automatic stops, also switch indicators are not used.

Bond wires are fastened to the rails as shown in Fig. 291. The clips which hold them in place appear in Figs. 292, 293.

Fig. 294 shows the type of insulated joint used. Figs. 295, 296, 297, show how the different switch rods are insulated and details of the insulation appear in Fig. 298.

Signal and bridge foundations are of concrete. They are shown in Figs. 299, 300, 301, 302. Fig. 303 is a table of dimensions for foundations. Fig. 304 shows how signal foundations are arranged with respect to the track.



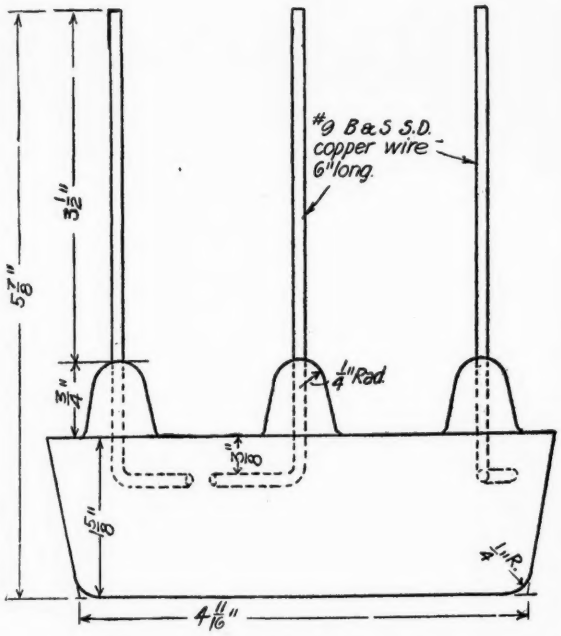


Fig. 306. Gravity Battery Zinc, P. R. R.

Fig. 307 is the standard semaphore lantern. The fount is shown in Fig. 308.

Crossovers are pipe connected and fitted with switch boxes as shown in Fig. 309. Fig. 310 shows the operating lever which is placed between the rails so that the crossover cannot be operated while any part of a train is standing upon it. Figs. 311, 312 shows how track circuits are taken through crossovers.

Circuits for wireless controlled automatic electro-pneumatic block signals are shown in Figs. 313, 314, and the corresponding wiring diagrams in Figs. 315, 316. Typical electric locking circuits for an electro-pneumatic interlocking plant are shown in Fig. 317 and locking circuits for four cases of outlying switches in Figs. 318, 319, 320, 321.

Relays for d. c. track circuits conform to R. S. A. specifications and are of 5 ohms resistance. Both neutral and polar types are used. A. c. relays are of the galvanometer, vane

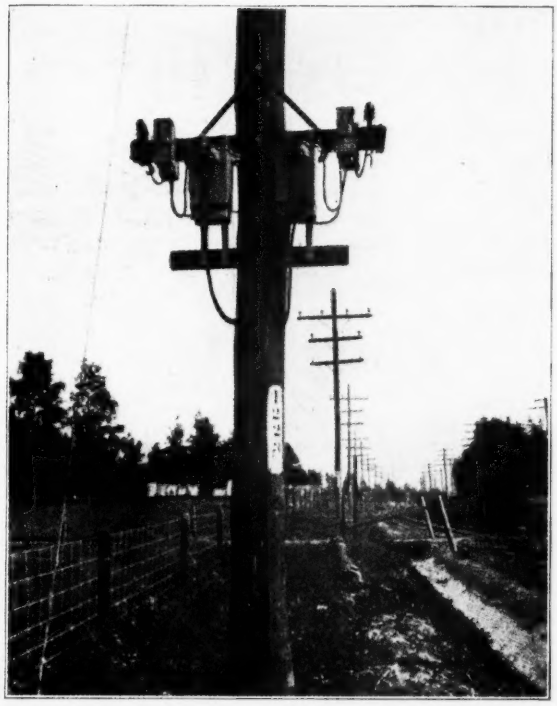


Fig. 325. Transformers, P. R. R.

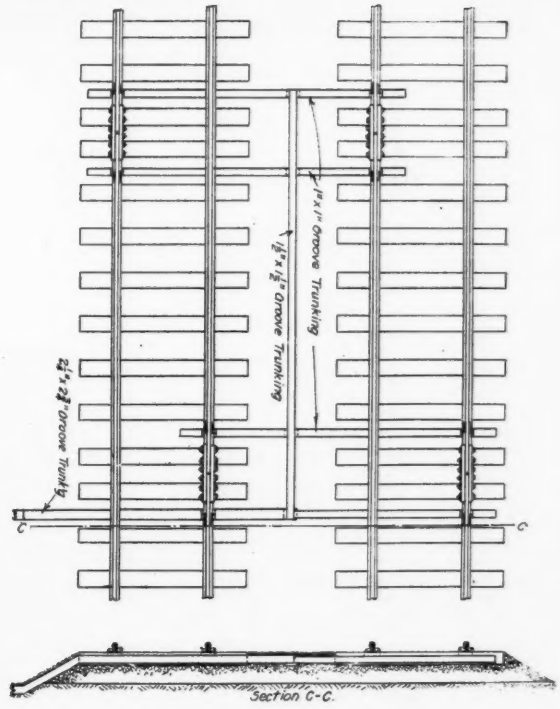
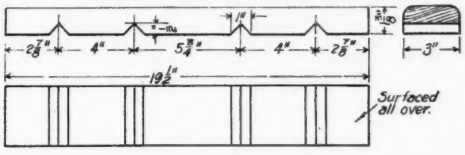


Fig. 290. Trunking Layout, P. R. R.



All trunking, capping and conduit to be made from well seasoned short leaf, loblolly or sap pine; Creosoted. Material to be sound, square edge; knots to be inter-grown perfectly sound and not over 1" in diameter.

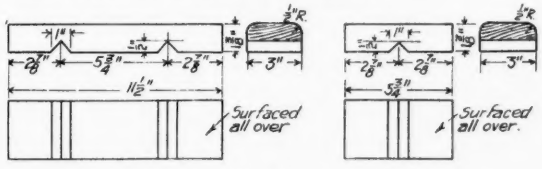


Fig. 305. Cable Supports, P. R. R.

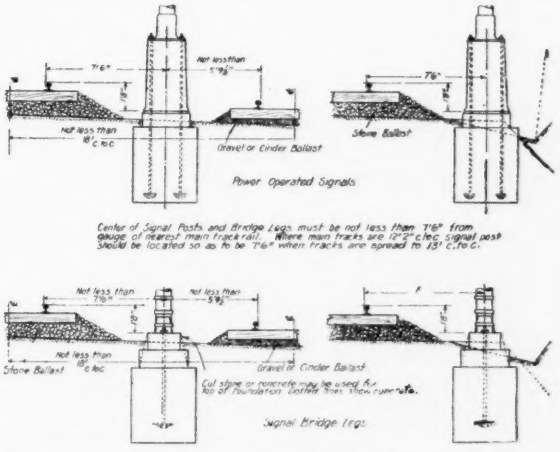


Fig. 304. Arrangement of Signal Foundations with Respect to Track, P. R. R.

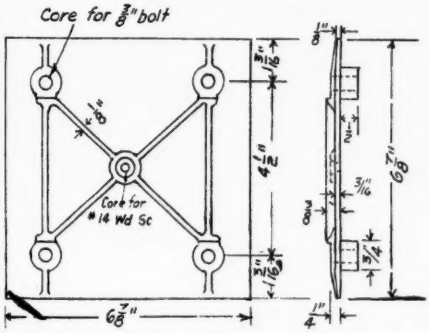


Fig. 286. Bolt Plate for Blades, P. R. R.

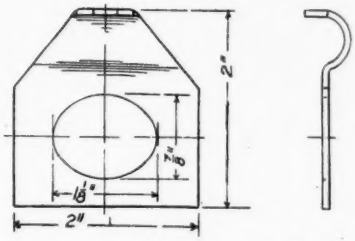


Fig. 293. Bolt Clip, P. R. R.

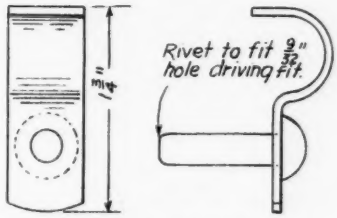


Fig. 292. Rivit Clip, P. R. R.

and motor types, various arrangements of circuits being in use.

The following sizes and classes of wire are used: For line, No. 10 B. & S. gauge hard drawn, weather proof, for bootlegs and leads to track, No. 9 B. & S. gauge rubber covered; for leads from line and to signals, No. 12 B. & S. gauge rubber covered, in chutes, No. 9 B. & S. gauge flexible rubber covered; all copper.

The following specifications govern:

Gravity Zincs.

"Zincs shall be made from virgin spelter, thoroughly amalgamated with mercury, cast at a low temperature, uniform

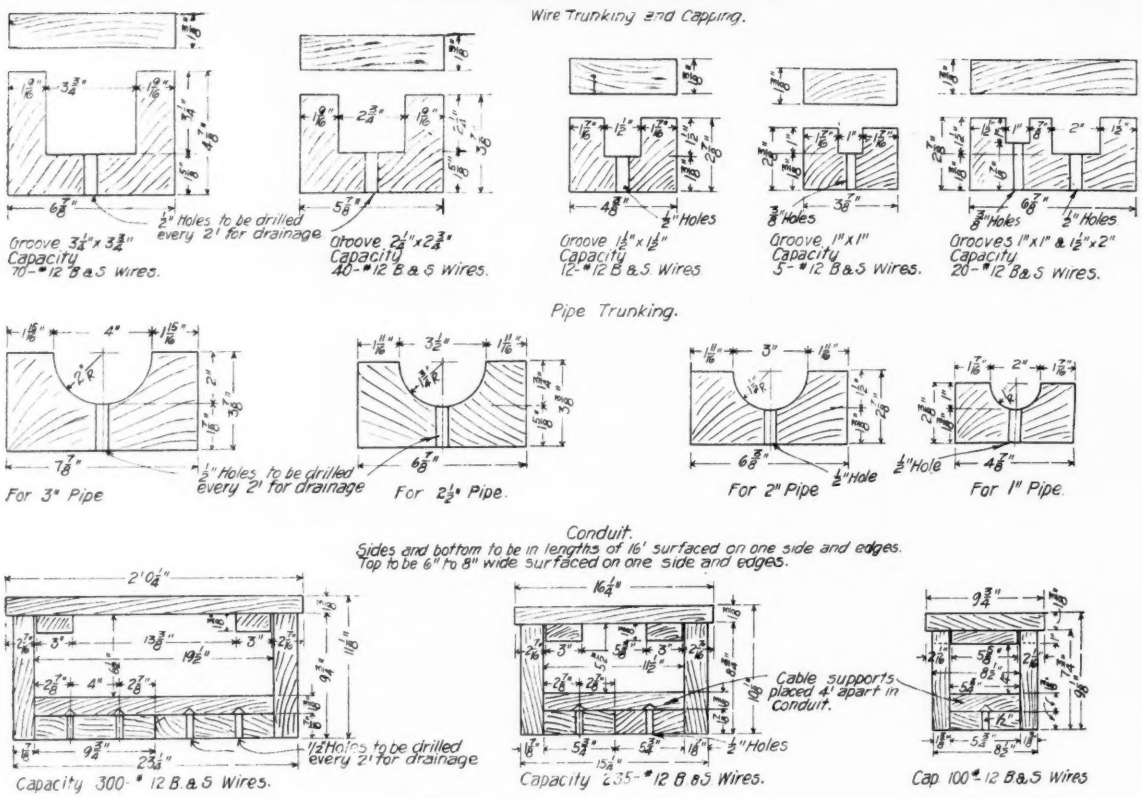

Wire Trunking and Capping.
Groove 3¼"x3¾" Capacity 70-#12 B&S wires.
½" Holes to be drilled every 2' for drainage
Groove 2¾"x2¾" Capacity 40-#12 B&S Wires.
Groove 1½"x1½" Capacity 12-#12 B.S. Wires
Groove 1"x1" Capacity 5-#12 B&S Wires.
Grooves 1"x1" & 1½"x2" Capacity 20-#12 B&S Wires.
Pipe Trunking.
For 3" Pipe
½" Holes to be drilled every 2' for drainage
For 2½" Pipe.
For 2" Pipe
½" Hole
For 1" Pipe.
Conduit.
Sides and bottom to be in lengths of 16' surfaced on one side and edges.
Top to be 6" to 8" wide surfaced on one side and edges.
Capacity 300-#12 B.&S Wires.
½" Holes to be drilled every 2' for drainage
Cable supports placed 4' apart in conduit.
Capacity 235-#12 B&S Wires.
Cap 100-#12 B&S Wires

Fig. 287. Trunking and Capping, P. R. R.

in size and weight, free from flaws and mechanical defects and have a smooth outer surface. A fracture of the zinc must show the grain firm and close.

"Weight. The zincs shall weigh four (4) pounds each.

"Chemical composition of the finished zinc shall be as follows:

"Mercury—Not less than 2.00 per cent.

"Iron—Not more than .10 per cent.

"Lead—Not more than .50 per cent.

"Other impurities—Not more than .40 per cent.

"Zinc—Not less than 97.00 per cent.

"When a shipment of zincs is received, an examination will be made to see that the physical requirements are fulfilled. If the physical requirements are fulfilled, one zinc from each 100 or fraction thereof will be taken for chemical analysis. The results of this analysis shall decide whether the entire shipment will be accepted or rejected.

"In case of controversy with the manufacturer over rejected material, the methods used in the checking chemical analysis shall be those used in the laboratory of the purchaser.

"Samples representing rejected material will be retained in the laboratory for not more than two weeks. If at the end of that period the manufacturer has not given instructions for the return of same, the material represented by the samples shall be returned at his risk, he paying the freight both ways in either case."

Signal Roundels and Lenses.—General.

"Material—All glasses must be of clear uniform solid color, containing the highest proportions of lead compatible with durability and securing the required color and must have specific gravity of not less than 2.75. Chipped or flashed glasses will not be accepted.

"Workmanship.—Workmanship shall be of the best, and glasses must be true to size and form, and practically free from bubbles, streaks and wrinkles.

"Color—Red, green, yellow and blue glasses will be purchased.

"Wrapping—Each glass must be wrapped in paper of corresponding color.

"Tests—The manufacturer must test each glass, placing thereon a label showing the photometric values.

"The purchaser reserves the right to make repetition of the above test, to insure that only material meeting the requirement is accepted, and all materials not meeting such requirements will be rejected.

"All red glasses must be submitted to the sodium test.

"Samples—The manufacturer must submit samples of glasses, showing the extreme limits of colors which it is proposed to furnish. These shall bear labels showing the photometric values, and if approved will be kept in the office of the Signal Engineer as standards.

"Rejected Material.—The purchaser will notify the manufacturer promptly as to rejected material, which will be retained not longer than two weeks from date of notification. If at the end of that time the manufacturer has not advised the purchaser as to disposition, such material will be returned to the manufacturer at his risk, the manufacturer paying the freight both ways in either case.

Roundels.

"Design.—Roundels must be of diameter specified in order and between .21-inch and .29-inch thick.

"Roundels will be subject to spectro-photometric analysis. The following table gives an analysis of roundels of the various colors of medium intensity, the letters, indicating lines of the spectrum, and the figures showing percentages of light transmission at the different points. Roundels of medium intensity should transmit light as nearly as possible of this composition, a reasonable variation being allowed for light anld dark limits:

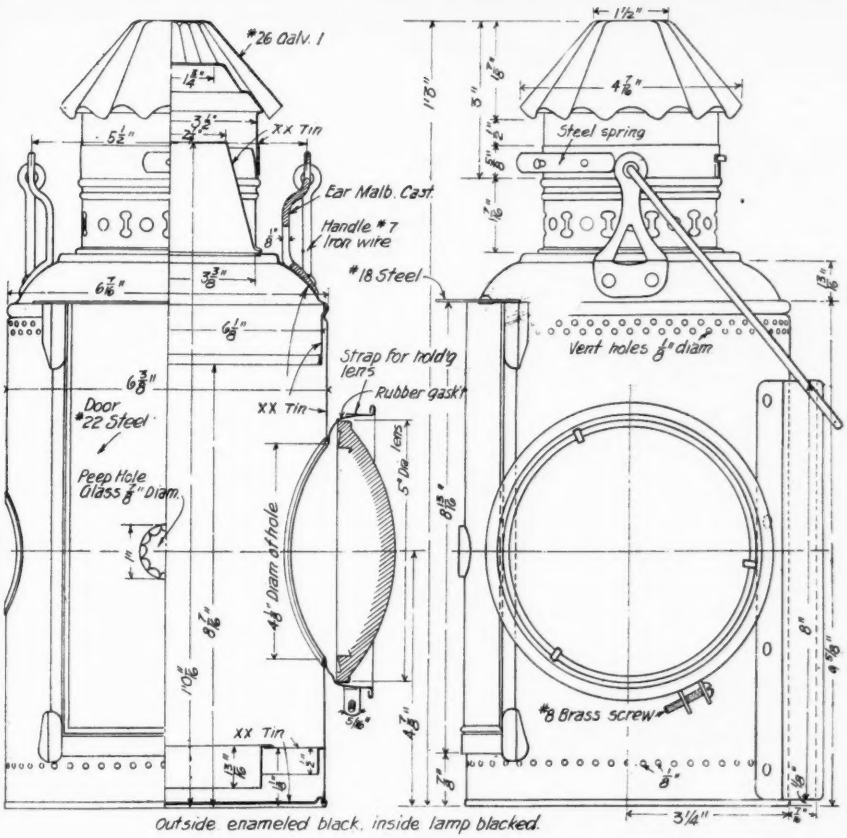


Fig. 307. Semaphore Lantern, P. R. R.

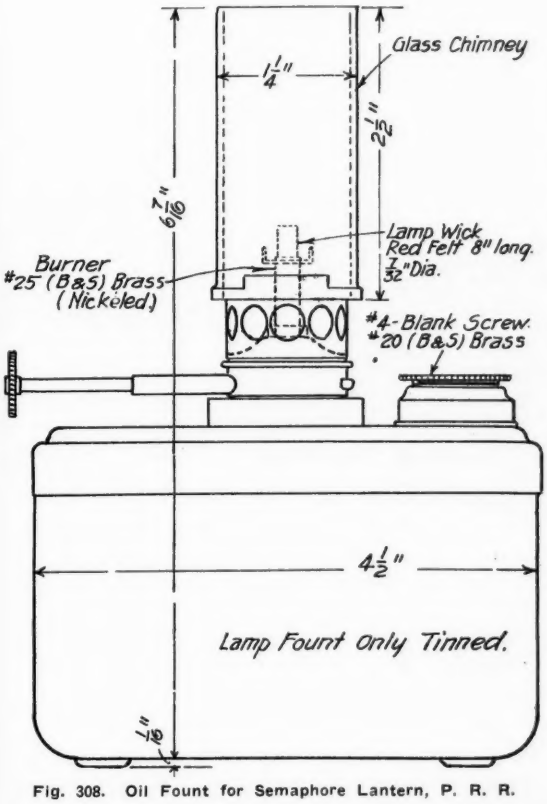

Glass Chimney
Lamp Wick Red Felt 8" long. 7/32" Dia.
Burner #25 (B&S) Brass (Nickeled)
#4-Blank Screw #20 (B&S) Brass
Lamp Fount Only Tinned.

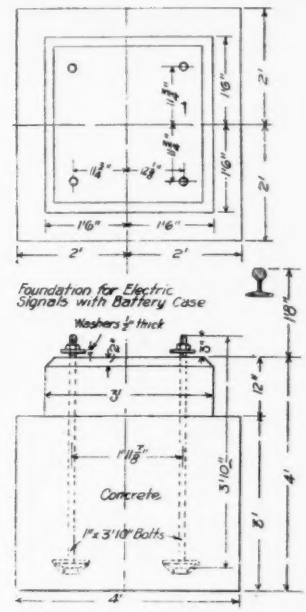
Fig. 308. Oil Fount for Semaphore Lantern, P. R. R.

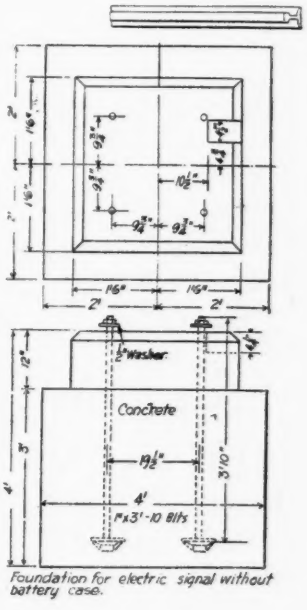
"F" Shown above is minimum depth. It must be increased as necessary to obtain proper anchorage.

Table for Bridge Foundations

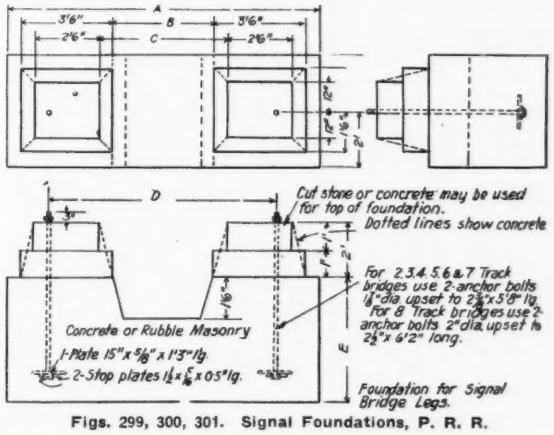
Size of Bridge	A	B	C	D	E	F
2 Track	11'10"	3'10"	4'10"	8'7⅞"	4'6"	8'7⅞"
3 "	"	"	"	"	"	8'1⅛"
4 "	"	"	"	"	"	7'7⅜"
5 "	12'4"	4'4"	5'4"	9'1⅝"	"	"
6 "	"	"	"	"	"	"
7 "	13'4"	5'4"	6'4"	10'1⅝"	"	"
8 "	13'10"	5'10"	6'10"	10'7⅝"	5'0"	"

Fig. 303. Dimensions for Foundations, P. R. R.

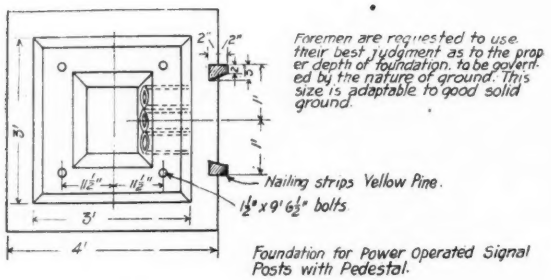




Foundation for electric signal without battery case.


Cut stone or concrete may be used for top of foundation. Dotted lines show concrete
For 2.3.4.5.6 & 7 Track bridges use 2-anchor bolts ¼" dia. upset to 2¾"x5⅛" lg. For 8 Track bridges use 2-anchor bolts 2" dia. upset to 2½"x6'2" long.
Concrete or Rubble Masonry
1-Plate 15"x5⅛"x1'3" lg.
2-Stop plates 1½x⅝x0'5" lg.
Foundation for Signal Bridge Legs.

Figs. 299, 300, 301. Signal Foundations, P. R. R.


Foremen are requested to use their best judgment as to the proper depth of foundation, to be governed by the nature of ground. This size is adaptable to good solid ground.
Nailing strips Yellow Pine.
1½" x 9' 6½" bolts.
Foundation for Power Operated Signal Posts with Pedestal.

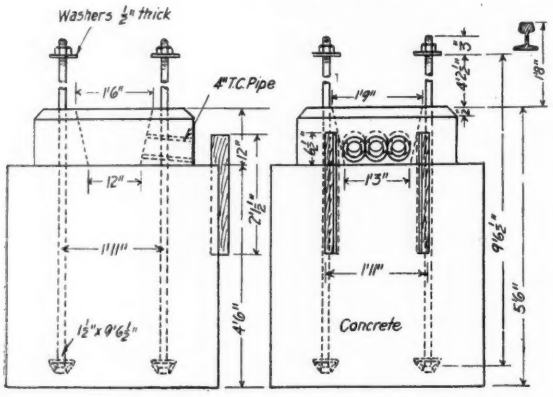
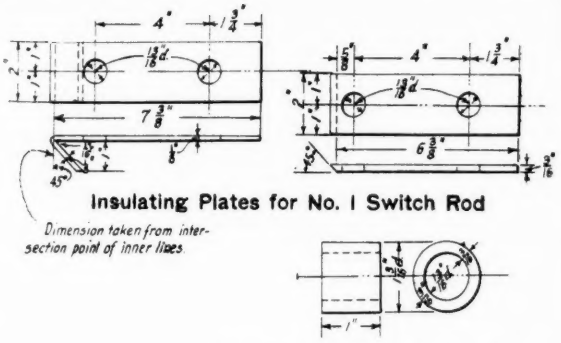


Fig. 302. Signal Foundation, P. R. R.


Insulating Plates for No. 1 Switch Rod
Dimension taken from intersection point of inner lines.
Fibre Collar for all Switch Rods

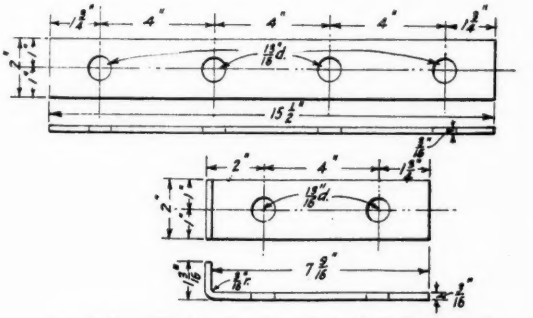


Fig. 298. Details of Switch Rod Insulation, P. R. R.

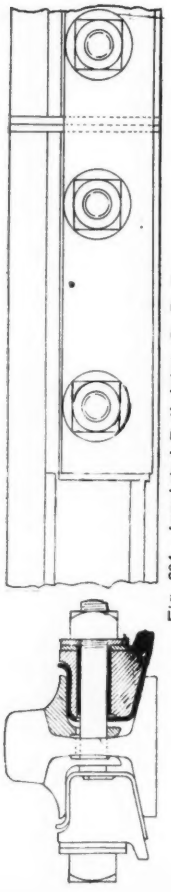


Fig. 294. Insulated Rail Joint, P. R. R.

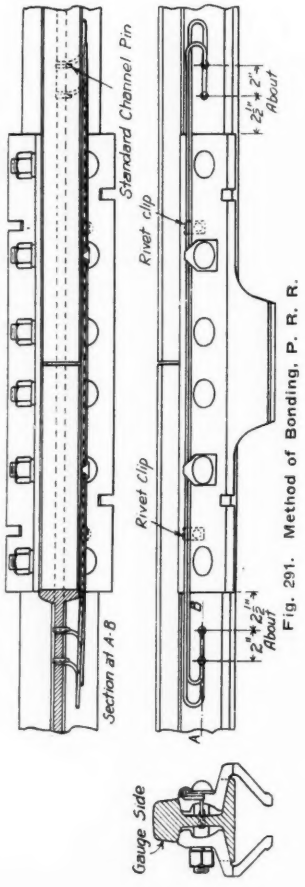
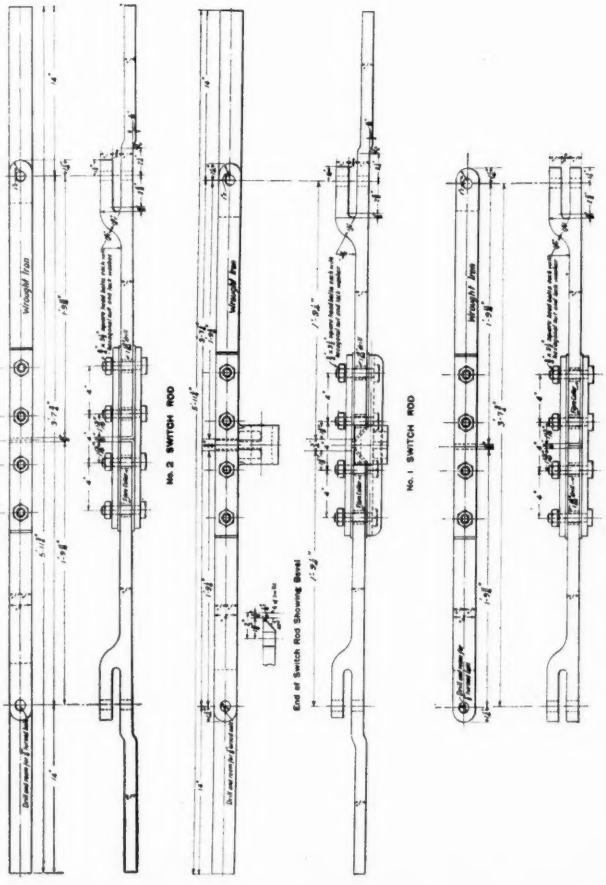


Fig. 291. Method of Bonding, P. R. R.



Figs. 295, 296, 297. Insulated Switch Rods, P. R. R.

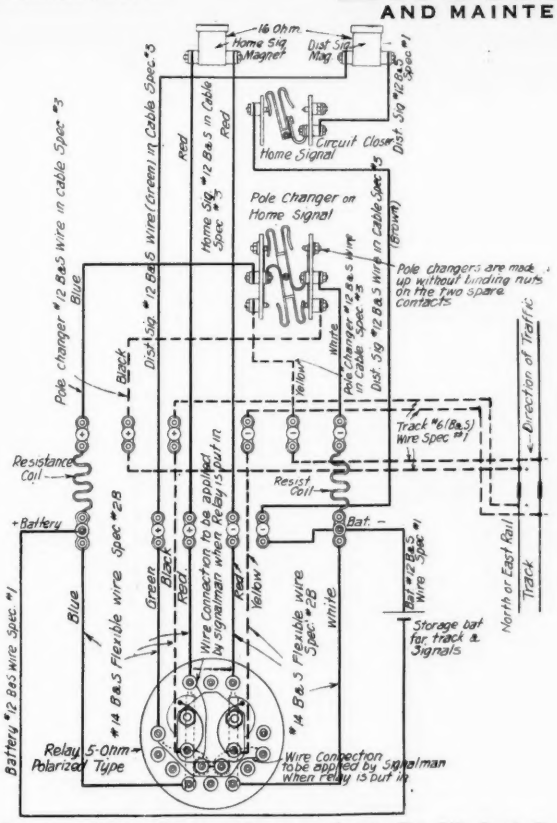

16 Ohm.
Home Sig. Magnet
Dist. Sig. Mag.
Home Signal
Circuit Closer
Pole Changer on Home Signal
Pole changers are made up without binding nuts on the two spare contacts
Pole changer #12 Ba.S wire in cable Spec "3
Blue
Dist. Sig. #12 Ba.S wire (Green) in Cable Spec "3
Red
Home Sig. #12 Ba.S in Cable Spec "3
Red
Dist. Sig. #12 Ba.S Spec "1
Dist. Sig. #12 Ba.S wire in Cable Spec "3 (Brown)
Pole Changer #12 Ba.S wire in Cable Spec "3
White
Black
Yellow
Track #6 (Ba.S) Wire Spec "1
Direction of Traffic
Resistance Coil
Resist Coil
+ Battery
Bat. -
Bat #12 Ba.S Wire Spec "1
Green
Black
Red
Red
Yellow
#14 Ba.S Flexible wire Spec "28
White
Wire Connection to be applied by signalman when Relay is put in
Storage bat for track & Signals
North or East Rail
Track
Battery #12 Ba.S wire Spec "1
Relay 5-Ohm Polarized Type
Wire connection to be applied by Signalman when Relay is put in

Fig. 315. Wiring Diagram Corresponding to Fig. 313, P. R. R.

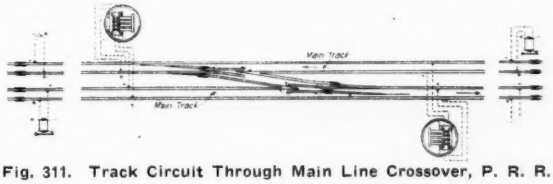


Fig. 311. Track Circuit Through Main Line Crossover, P. R. R.

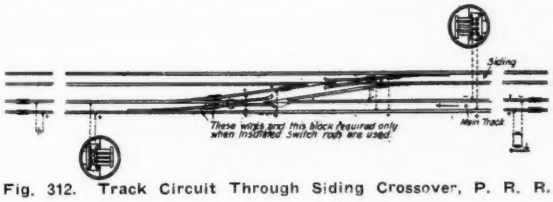


Fig. 312. Track Circuit Through Siding Crossover, P. R. R.

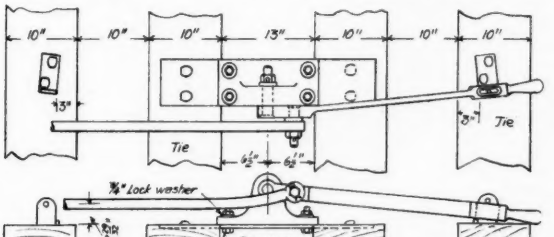


Fig. 310. Operating Lever for Pipe Connected Crossover, P. R. R.

	A	a	B	C	D	E	b	F	G	H
Red	60	65	70	72	0	0	0	0	0	0
Green	0	0	0	0	4	27	40	45	25	0
Yellow	0	38	50	43	41	12	9	3	0	0
Blue	0	0	0	0	3	4	6	24	40	46

"Briefly describing the above photometric values.

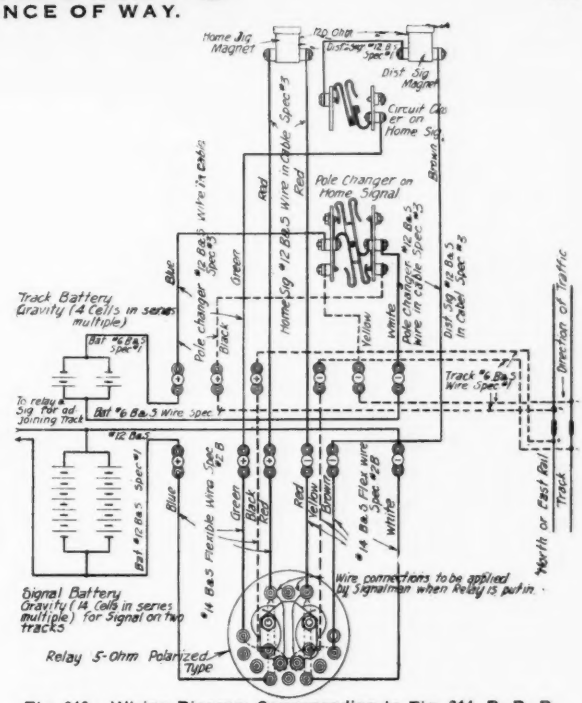

Home Sig. Magnet
Dist. Sig. Magnet
Circuit Closer on Home Sig.
Pole Changer on Home Signal
Track Battery Gravity (4 Cells in series multiple)
Pole changer #12 Ba.S wire in cable Spec "3
Blue
Green
Home Sig. #12 Ba.S wire in Cable Spec "3
Red
Dist. Sig. #12 Ba.S in Cable Spec "3
Brown
Yellow
White
Black
Track #6 Ba.S Wire Spec "1
Direction of Traffic
To relay & Sig. for adjoining Track
Bat #6 Ba.S Wire Spec "1
#12 Ba.S
Bat #12 Ba.S Spec "1
#14 Ba.S Flexible Wire Spec "28
Green
Black
Red
Red
Yellow
Brown
#14 Ba.S Flex. Wire Spec "28
White
North or East Rail
Track
Wire connections to be applied by Signalman when Relay is put in
Signal Battery Gravity (14 Cells in series multiple) for Signal on two tracks
Relay 5-Ohm Polarized Type

Fig. 316. Wiring Diagram Corresponding to Fig. 314, P. R. R.

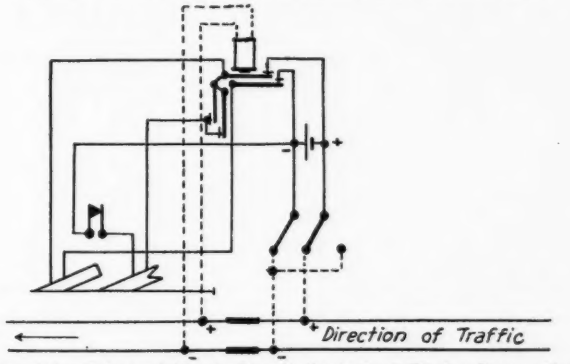


Fig. 313. Polarized Track Circuit Control of Electro-Pneumatic, Automatic Block Signal, Storage Battery, P. R. R.

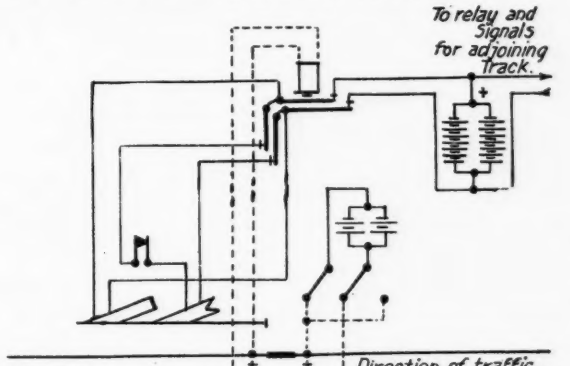


Fig. 314. Polarized Track Circuit Control of Electro-Pneumatic, Automatic Block Signal, Gravity Battery, P. R. R.

"Red.—Will be of such quality that all yellow rays of light are absorbed, the spectrum being either red or red and orange. The photometric value shall be, light, 130; standard, 100; dark, 70.

"Green.—Will be of the color known as Admiralty green, having a slightly bluish tint. The spectrum shall show very

Figs. 295, 296, 297. Insulated Switch Rods, P. R. R. No. 3 Switch Rod

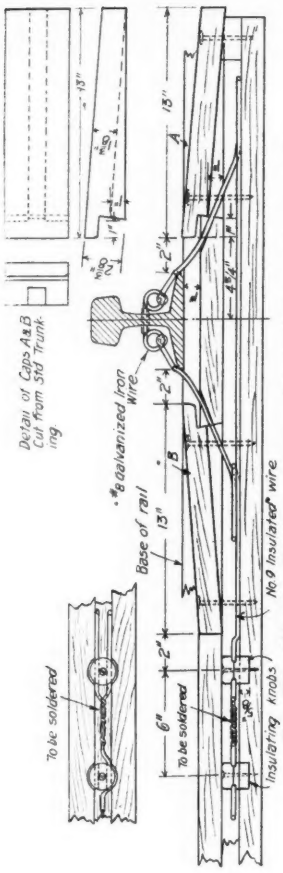

Detail of Caps A & B Cut From Std Trunking
*8 galvanized iron wire
Base of rail
No 9 Insulated wire
Insulating Knobs
To be soldered
To be soldered

Fig. 288. Wooden Bootleg and Wire Connections to Rail, P. R. R.

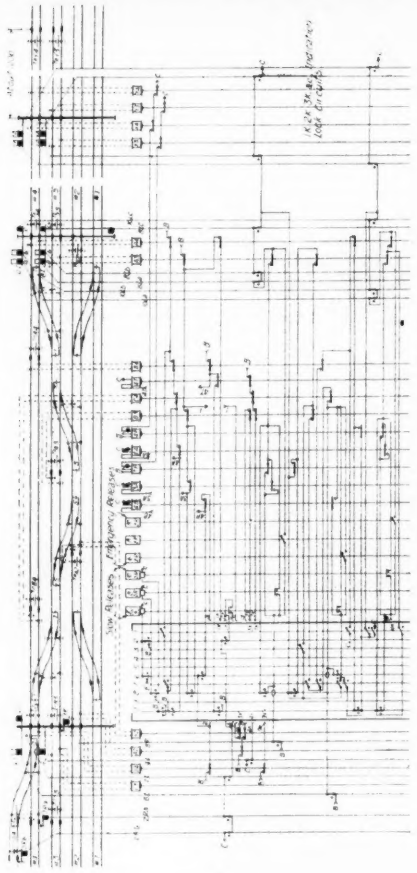


Fig. 317. Typical Electric Locking Circuits for Electro-Pneumatic Interlocking Plant, P. R. R.

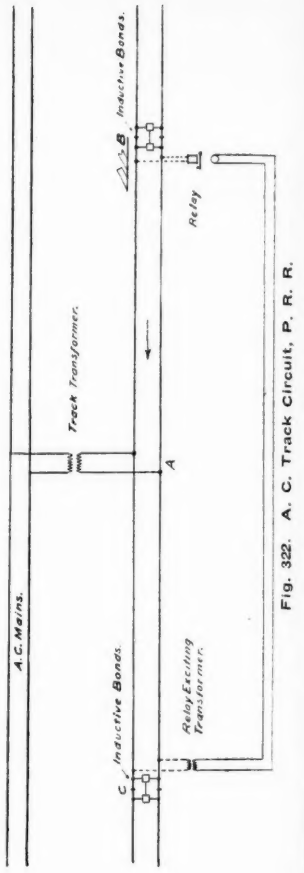


Fig. 322. A. C. Track Circuit, P. R. R.

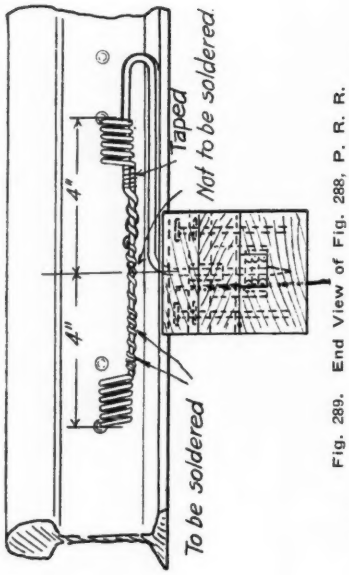


Fig. 289. End View of Fig. 288, P. R. R.

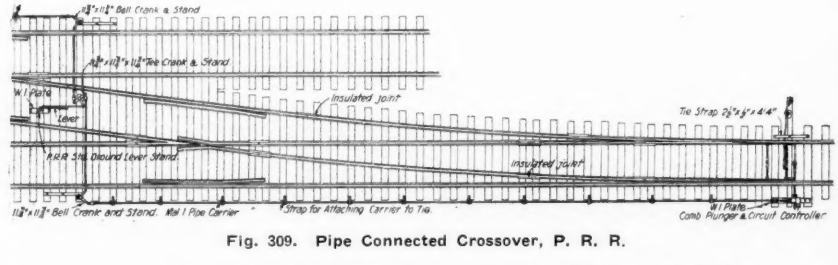
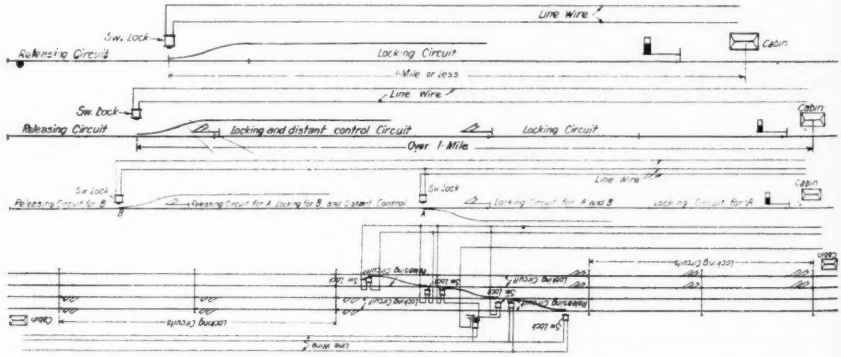


Fig. 309. Pipe Connected Crossover, P. R. R.



Figs. 318, 319, 320, 321. Electric Locking Circuits for Outlying Switches, P. R. R.

little yellow, being a full green with some blue. The photometric values shall be, light, 125; standard, 100; dark, 75.

"Yellow.—Will give a spectrum showing a full yellow band, most of the red and slightly of the green. The photometric value shall be light, 120; standard, 100; dark, 80.

"Blue.—Will give a spectrum having a full blue band, with a narrow band of green. The photometric value shall be light, 125; standard, 100; dark, 75.

Lenses.

"Design—All lenses must be of the optical pattern, focusing

to a plane rather than to a point, and must be of the polyzonal type, with smooth outer face. All parts of the lens must focus to an area not exceeding ⅜ inches in diameter for all lenses up to the 6-inch size, nor exceeding ½-inch in diameter for the larger sizes; must be so designed that the divergence of the projected beam (i. e., spread), with flame 1 inch broad, shall not exceed 1 foot from the axis in 8 feet.

"When observed at a distance of 30 or 40 feet in 8 feet, a small flame oil burner being placed in the focus, the whole lens shall be equally illuminated, the 'risers' on the inner surface showing only as narrow dark rings.

"All lenses 6⅜ inches and over diameter must have at least five zones, and the smaller lenses four, and must be corrugated inside.

"Color.—Colored corrugated lenses must have the same photometric and spectro-photometric values as roundels of the same color, but allowance will be made for divergences due to irregularities of manufacture.

"Focus.—The focus of each lens must be stamped on the outer zone."

Bonding.

Bond wires to be 54 inches long; No. 6 B. & S. copper or copper-clad steel through stations, road crossings and tunnels.

No. 8 B. W. G. galvanized iron at all other points.

At joints in road crossings and station platforms, the planking must be cut back ¾ inch from head of rail to allow inspection of bond wires.

Frogs must be bonded as part of track.

Holes for channel pins must be drilled in oil and plugged same day as drilled.

Rivet clips may be applied to rail in track without removing bolts.

Drill splice with standard 9/32-in. bond drill.

Bolt clips should be used on all new rails.

Fig. 322. A. C. Track Circuit, P. R. R.

G. E. Ellis, Sig. Engr., K. C. Term.

ELECTRIC SIGNALING FOR ELECTRIC RAILWAYS.*

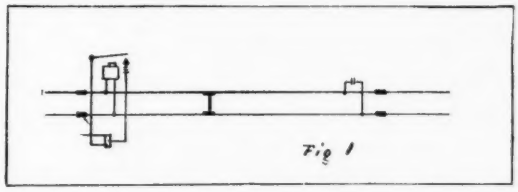
Historical.

First Electric Installation and Developments.

It is less than twenty-five years since the first commercial electric car started in Richmond, Va. For the first fifteen years this development was limited to the replacing of horse cars of equivalent type, with but slightly increased speed, but operating under similar conditions. The next step was in the field of Interurban roads with longer hauls and speed approaching that of the suburban lines. The last step was the electrification of existing steam roads, with the complexity of problems existing in large terminals.

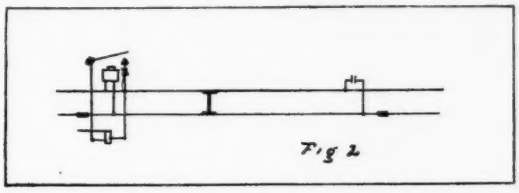
The speed attained during the first fifteen years did not call for the protection offered by signals, and in the growth of the industry the railway engineers were not called upon to progress along signaling lines, so that when the demand arose, the electric railway manager naturally turned to steam railway signal engineers and practice to govern such signals as were required. However, there appeared to be an insurmountable difficulty in using on electric lines what had in the previous twenty-five years become standard steam railway practice, that is, closed track circuits for the control of the signals. This problem on steam roads was solved in 1873 and became more or less universal by 1895.

The difficulty was that on electric lines the two traffic rails were universally employed as the return conductors for the propulsion current from the cars to the power houses. It was apparent that this current in the rails would continuously energize the one volt relay used with track circuits on steam roads and thus render a signal system inoperative. A further difficulty in the solution of the problem was that the railway engineers were entirely ignorant of the principles and practice of signaling, and the signal engineers were practically ignorant of electrical engineering, so it remained for some one to combine a knowledge of both arts to solve the problem.



The two sets of engineers were further at variance. The railway engineer wanted a signal system, but he must have the two rails of his track return undisturbed. The signal engineer might perhaps devise a signaling system, but to make it operate, it looked to him as though in any event it would be necessary to give up one of the traffic rails as a power return, and insulate it for signaling purposes. This was an apparent deadlock, but out of such chaos a system was finally developed which satisfied the requirements of both branches of the service.

In the steam railway track circuit systems one or both of the rails are divided into blocks or sections by insulated joints. Current from a battery of about one volt at one end of the block energized a relay at the farther end of the block, through the two rails, thus closing a local signal circuit. A car entering the block short circuits the battery, robbing the relay of current, and sets the signal to stop by gravity as shown in Fig. 1.



In this figure both rails are divided into sections or blocks by insulated joints. The same electrical result is obtained, of course, by dividing only one of the rails as shown in Fig. 2.

When the railway signal engineer came to apply this steam railway practice in block signaling on electric railways, he was confronted with a very different set of conditions from those

*A committee report to the Railway Signal Association.

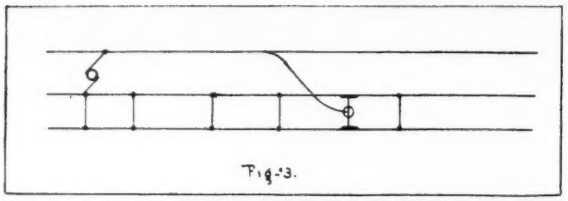


Fig. 3.

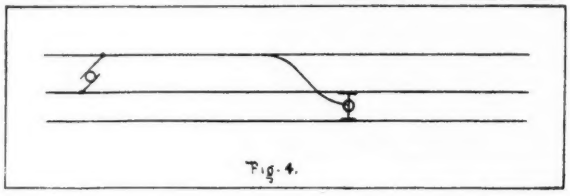


Fig. 4.

with which he had become familiar. The rails of the tracks on steam roads were fairly well insulated from each other, so that it was simple to create the difference of potential between the two rails, which was necessary to operate the track circuit, but in the electric railway instead of the rails being insulated from each other, they were actually connected together, with what the electric railway engineer calls "cross bonds," which were pieces of wire with no little or no ohmic or inductive resistance. The problem, therefore, of producing a difference of potential between the two rails while such cross bonds remained in place was at first beyond him. The first step then, and one which the signal engineer of that day deemed absolutely necessary was to remove entirely all of these cross bonds. The road, as the signal engineers found it, is shown in Fig. 3.

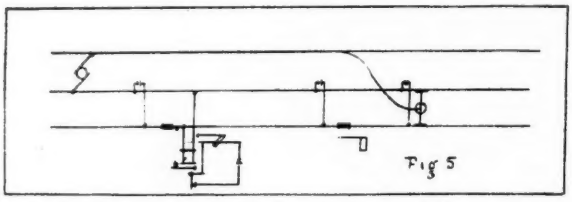


Fig 5

Fig. 4 shows the same roads with the cross bonds removed, which was the first step deemed necessary by the signal engineer in endeavoring to adapt a signal system to an electric road.

These cross bonds were removed against the vigorous protests of the railway engineer, but the signal engineer had to go still further to install the steam road signal system on an electric road. He not only had to eliminate the cross bonding but he also had to break one rail, insulate it, and appropriate it for his signal system as shown in Fig. 5.

It will be noticed that this diagram, Fig. 5, is the same as Fig. 2, except that a trolley system has been added to a steam road and a polarized relay, such as had previously been employed on steam roads was substituted for a neutral relay. Of course, with one rail insulated and given up for signaling purposes, the problem theoretically was a very simple one, as two independent circuits were available, but with a common return.

The polarized relay was used so that if an abnormal amount of direct propulsion current flowed through the relay (being connected in the circuit so that the power current would always be in an opposite direction from the battery current), it would attract the armature in an opposite direction and open the local circuit and cause the signal to assume the stop position.

The next step was the addition of another circuit controller in the signal controlling circuit, operated by a neutral armature.

Direct Current Track Circuits Used with Direct-Current Propulsion.

Direct current track circuits have been successfully used in connection with electric roads using direct current propulsion since 1901. Their use, however, is limited and the number of track circuits in operation at the present time is very small compared with those operated with alternating current.

There are several conditions incident to their use which must be favorable to secure safe and satisfactory results. The interference with the propulsion return system due to giving up the use of one rail for block signal purposes, the possible interference with the proper working of the track relay by the propulsion return current and the comparatively short length of block which may be operated, may be considered the chief arguments against such a system. On the other hand, a system of this type, well installed on a road where the conditions are favorable and maintained under a rigid system of inspection, possess points of merit, which, in the opinion of some, make its use desirable. The rugged type and small amount of apparatus required, consequently the simplicity, the positive operation of the apparatus and the better understanding which the average repairman has of direct current, compared with alternating current, with the result that defects may be remedied in the least possible time, are its principal points of advantage.

When used on electric roads where the entire elevated steel structure is included in the return system, the loss of the one rail used for track circuits from the total return capacity is of little importance. Great care must be used in maintaining perfect bonding on the remaining return rail, both between rail lengths and between it and the structure. On subway, tunnel or surface roads, the loss in return capacity must be compensated for by more copper than otherwise would be required. Here again much depends upon the bonding between the return rail and supplementary cables.

The number and location of power stations, the propulsion load centers and return capacity are all factors which determine the feasibility of installing a direct current track circuit signal system on a road using direct current propulsion, and they do determine the degree of safety derived from such a system. In other words, having determined that the conditions of the d. c. propulsion power system are such that the voltage drop in the power ground return between any two points is reduced to a minimum under maximum load conditions, the use of d. c. track circuits will be a success. One point in its favor is the perfect shunting as compared with a. c.

Installation of Signal Systems Using Direct Current Track Circuits with Direct Current Propulsion.

Boston Elevated Railroad.

The first system of d. c track circuits used with d. c. propulsion was installed in 1901, on the Boston Elevated, which

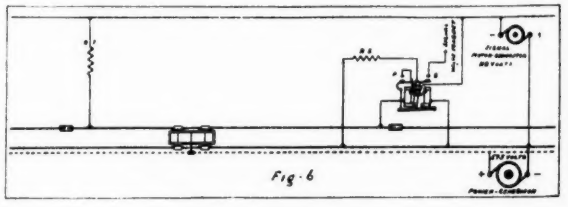


Fig. 6

also includes two and one-half miles of subway. The track circuit voltage employed was 10 volts, the blocks were short and the return rail bonded to the entire elevated steel structure, providing a return of 14,000,000 C. M. so that the drop across the rails due to the propulsion current should never normally equal the pick-up point of the track relay. In case it should, due to unusual conditions, the polarized armature would open the signal circuit, setting the signal at stop, thereby preventing a false proceed indication. This system was installed by the Union Switch & Signal Company, and comprised 175 electric-pneumatic signals (normal clear), 61 switches, and about 50 indicators of various types for various purposes.

Power Supply.

At each terminal and at each of the two intermediate junctions of the elevated road a motor generator set is placed from which the electrical energy for the block system is derived. These machines have a capacity of 50 amperes at 110 volts (5.5 k.w.) and any two of them operated in parallel suffice for the energy required. Normally, they deliver 40 amperes at 90 volts each, the total electrical energy generated being 7.2 k.w. The negative pole of the generators which develop the energy employed for propulsion is that one which is connected with the ground and general return system, the positive pole being connected with the third rail.

Track Circuits.

The original type of track circuit used in this installation is shown by Fig. 6.

As shown, the block rail is negative, while the common or ground rail is positive of the track circuit. The track relay is of very heavy construction and is of the polarized type. The neutral coils of the relay are wound to 50 ohms, and the polarizing coil on the pivoted armature to 800 ohms resistance. The system is operated from a 110-volt d. c. power line as follows:

From the common or ground rail, positive current is taken through the neutral coils of the relay to the block rail, thence through resistance R1 to the negative feeder. With the block clear the neutral coils are thus energized and the contact of the pivoted armature is caused to make contact at P, which completes the polarizing circuit from the positive rail through resistance R2 and the polarizing coil to the negative feeder, and allows sufficient current flow to energize the polarizing coil so that it will cause contact S to close. The current through resistance R2 is then divided between the polarizing circuit through contact P and the signal controlling circuit through contact S. This type of relay is adjusted to have its neutral armature raise on about 5.5 volts, and shunt at 4 volts, the average across relay terminals being from 15 to 18 volts. The resistance R1 in series with track circuit varies from 25 to 300 ohms with the length and condition of block.

From Fig. 6 it will be seen that the block rail which is negative to the signal circuit is also positive to the propulsion circuit, but in case defective bonding or lack of capacity in the negative rail of the propulsion circuit should cause positive propulsion current to flow through the neutral coils of the relay to the negative propulsion rail, the current would be in the reverse direction from normal, and consequently the polarity of the neutral coils would be reversed. This would cause the polarizing coil to operate in the reverse direction opening contact S, and thus keep open the signal controlling circuit.

London Subway.

Track circuit as shown and described in Fig. 7 below is now being used in replacing the type described above.

The system installed on the London subway is the same as on the Boston Elevated except that two relays are used, one

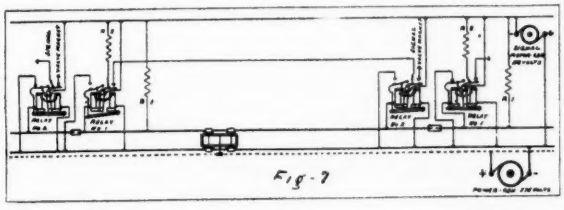
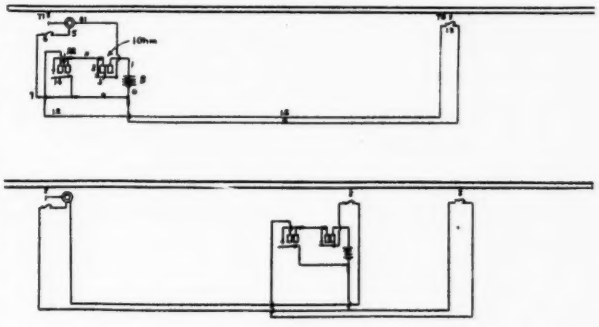


Fig. 7

at each end of the block, as a further precaution against leakage currents. The signals are electro-pneumatic and mechanical automatic stops are employed. An interesting feature in connection with this London plant is the track arrangement. Owing to certain regulations of the Board of Trade limiting the drop in the return propulsion current circuit, this road uses a four-rail system with boosters. The power current goes out over a third rail, through the cars and back over a fourth rail to the power house. The running rails, therefore, do not normally carry the propulsion current and the signal system need only to provide against leakage currents.

Fig. 7 shows a type of d. c. track circuit which is extensively used. With this type of track circuit, two polarized relays are used in place of one, the principal of which is that any tendency of the voltage drop in the power ground return system to interfere with the signal system will be reduced to a minimum by the addition of a second relay at the opposite end of block, and having the signal controlling wire pass through the polarized contacts of both relays. With this arrangement should the voltage drop referred to ever equal that of the pick-up point of the track relay, so that the relay in the rear of the train would be energized, the relay at the leaving end of block would still remain open. Both relays are placed in multiple across the rails, the neutral coils being wound to 100 ohms, so that the combined resistance is such that the two relays take no more current to operate them than the single relay of 50 ohms. With the exception of the contact arm, which is made in two



Fairmount Park Transit Co.

Fig. 8

parts in place of one, to allow the use of two separate circuits, the general construction is the same as relay shown in Fig. 6. The polarizing coils are wound to 1,000 ohms. The only difference in the operation of the relay used with the double relay scheme is that the polarizing circuit from the positive rail is completed when contact P is made through the polarizing coil to the negative feeder, and is a separate circuit in itself. The signal controlling circuit is also a separate circuit, taking positive current from the positive rail through the signal valve magnet to contact S of No. 2 track relay, thence through line wire to contact S of No. 1 relay, and then through resistance R2 to the negative feeder.

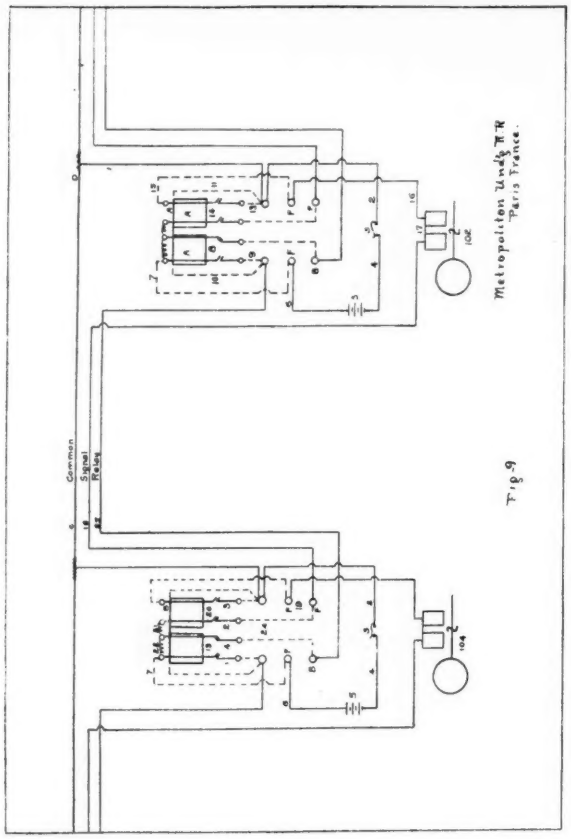
The Fairmont Park Transit Company, Philadelphia, Pa.

This system consists of enclosed automatic disc signals controlled by track instruments used with d. c. propulsion. By referring to Fig. 8 it will be noted that disc signal S is wound to 35 ohms resistance, and is normally held clear by 1 ohm stick relay R-1, and normally closed circuit controller 6 of track instrument T-1. The hold clear circuit is as follows:

From battery B, wire stick relay R-1, wire 2, contact 3, wire 4, motor magnet of disc signal S-1, wire 5, circuit controller 6, wire 7, common wire O to battery B. A car passing over track instrument T-1 will temporarily open circuit controller 6 and put signal S-1 to stop. Stick relay R-1 will open and hold signal S-1 at danger.

When the car passes over track instrument T-2 circuit controller 13 will be closed temporarily and this will energize restoring relay R-2, the circuit being as follows:

From battery B, wire 1, stick relay R1, wire 11, restoring relay R-2, wire 12, circuit controller 13, common wire O back to Battery B. Restoring relay R-2 which is wound to a resistance



of say, 500 ohms is now energized and closes the local restoring circuit for stick relay R-1 which is as follows:

From battery B, wire 1, stick relay R-1, wire 11, contact 14, wire 15, common wire O back to battery. The closed condition of stick relay R-1 now closes the motor magnet circuit of signal S-1 as previously explained and clears signal S-1.

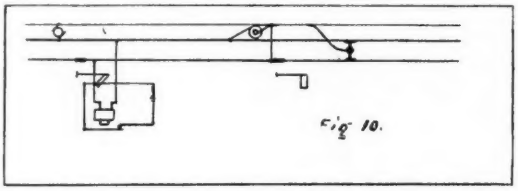
Metropolitan Underground Railroad, Paris, France.

Circuits.

By referring to Fig. 9 it will be noted that Signal 102 is held normally clear by normally energized stick relay A and B. The circuit for stick relay A is as follows:

From battery 5, wire 6, wire 7, contact point 6, wire 9, wire 10, relay magnets a, a, wire 11, wire 2 circuit controller 3 or track instrument wire 4, back to battery 5. Stick relay B at signal 104 is held normally energized by a similar circuit. The circuit for signal 102 is as follows:

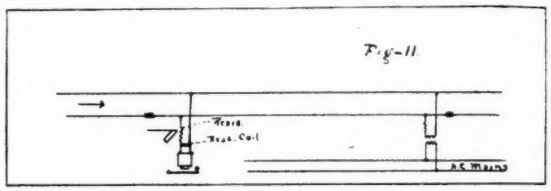
For common wire 0, wire 1, wire 13, contact point 14, wire 15, wire 16, motor magnet 17, line wire 18, wire 19, contact 20, wire 21, wire 22, wire 7, wire 6, battery 5, wire 4, circuit con-



troller 3 of track instrument, wire 2, wire 1, common wire 0 back to signal 102. Contact 14 of stick relay A provides block control for signal 102 and contact 20 of stick relay B at signal 104 provides overlap control which extends to the next signal (not shown).

A train passing signal 102 will operate track instrument and open circuit controller 3 and this opens the stick circuit for stick relay A which drops and the opening of contact 14 puts signal 102 to stop. When the train passes signal 104 the track instrument will open circuit controller 3 which drops stick relay B and this opens contact 20 which sustains the open condition of the circuit for signal 102 and this provides the overlap control. The de-energized condition of stick relay B closes back contact 23 and this restores stick relay A at signal 102 the current being as follows:

From common wire 1 at signal 104, wire 1, wire 2, circuit controller 3, wire 4, battery 5, wire 6, wire 7, wire 22, contact 23, wire 24, line wire 25, wire 10, relay magnets a, a, wire 11,

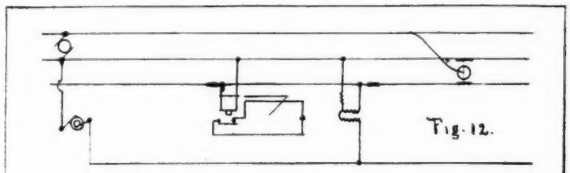


wire 1 and common wire 0 back to signal 104. This restoring action does not take place until the last wheels of the train have passed over the track instrument at signal 104, and circuit controller 3 is closed.

Alternating Current Track Circuits Used with Direct Current Propulsion.

The first installation of a signal system using alternating current with direct current propulsion was on an electric railway in California during the year 1903. In this installation an a. c. generator was substituted for the battery as shown in Fig. 1, and the relay responded to alternating current and not to direct current as shown in Fig. 10. With such a system the only effect of the propulsion current upon the signal indication is to give a stop signal when none is intended, as in case of conditions which would send a destructive amount of propulsion current through the relay coils.

Two schemes of alternating current track circuits are in use at the present time: the single-rail return system and the double-rail return system. In the one-rail system each track is insulated into block sections for signaling purposes, the other rail serving as a continuous return for the power current and as one side of the alternating current track circuit. In the latter



both rails are insulated into block sections and both are used for power return current. This is accomplished by the use of balanced impedence bonds and is used in preference to the single-rail system under certain conditions.

One-Rail System.

The single-rail scheme and some features of interest in its application will be found below.

Fig. 11 shows a typical alternating current track circuit using the single-rail scheme, and its relation to the propulsion system. As practically all of the propulsion current flows through the return rail within the length of the block, and relatively little through the block rail, there will be a drop in voltage in the former and not in the latter. Thus, a small amount of propulsion current will flow through the track relay at one end of the section and through the secondary of the track transformer at the other, the effect of which is to magnetize the iron of each to a certain extent, and, if, excessive, to diminish

the influence of the alternating signal current. In order to limit this effect of the propulsion current on the relay, a non-inductive resistance is connected in series with the relay and a reactance of low ohmic resistance in multiple with the relay. In like manner the track transformer is protected by a non-inductive resistance in series with it. As a further precaution against the magnetizing effect of the propulsion current, the iron of both the transformer and reactance coil is provided with an air gap. Fuses protect the apparatus from injury in case of a short circuit between the power and block rail. The resistance in the circuit with the transformer secondary serves the further purpose of limiting the flow of alternating current when the rails are short circuited by a train.

In describing the limitations of the one-rail system it is well to understand the cause and relation of the drop in the continuous rail caused by the propulsion current. This may be illustrated by Fig. 12. In the one-rail system in addition to the average drop occasioned in each block by the propulsion current from the territory under consideration, i. e., on the side of the block away from the power house, there is an additional drop caused by the rush of current from the car in that block seeking to escape at both ends.

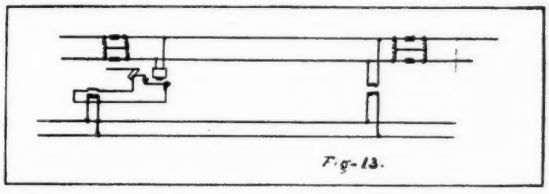


Fig. 13.

Two-Rail System.

The main features and adaptability of the single-rail system having been described in a general way, the two-rail system, which admits of universal adoption under all conditions, will now be described. The two-rail system is one that admits of the railroad retaining its original arrangement of tracks and power circuits and a signal system free from derangement from the operation of the railroad, and as reliable as in standard steam railroad practice.

Such a system was finally evolved about 1903, in which the railway engineer was enabled to retain both of his traffic rails as power return conductors without in any way affecting his railway tracks or power circuits, and the signal engineer was enabled to provide closed track circuits entirely free from possible interference from the power currents. The difference, as will be seen later, is inherent in the two-rail system which provides that the power current shall flow through the two rails in approximately equal quantities so that the potential between the rails is always essentially zero.

Signaling by the double-rail system, in which both rails are used as return conductors for the train propulsion current simultaneously with the alternating current block signaling current, is accomplished by the use of balanced impedence bonds connected across the rail insulations at the ends of the blocks. These bonds offer impedence of the signaling current, but not to an appreciable extent to the passage of the return train propulsion current. A good form of impedence bond is shown in Fig. 13 in which the propulsion current passes from the rails into the ends of the coil and out at the middle of the coil of the bond, or in at the middle and out at the ends. With equal amounts of return current in each rail the magnetizing effect on the iron is nil, but the signaling current which flows from end to end of the bond sets up a reactance, which maintains a difference of potential between the rails sufficient to operate the inductive track relay. Unlike the single-rail return system, the drop of voltage in both rails due to the propulsion return current is, under favorable conditions, nearly equal, so that little or no propulsion current flows through the track transformer at one end, or the track relay at the other end of the block. For this reason it is not necessary to interpose resistances between the track and this apparatus, or to connect an inductive shunt across the relay coils. The iron of the track transformer has a closed magnetic circuit, that is, it is without an air gap. Adjustable magnetic leakage filler blocks are inserted between the primary and secondary coils, causing a drop of voltage and limiting the current when the transformer is short circuited by a train in the block.

It is probably never true in practice that equal amounts of propulsion current are carried by each rail of a block owing to unequal resistance due to defective bonding and the like. The difference in the amount of current in the two rails is called unbalancing current, because its effect on the iron of the bond is not neutralized by an equal amount of current through the opposite half of the bond. In order to reduce the magnetizing effect of the unbalanced propulsion current on the bond so that its reactance to the alternating signaling current will undergo but little change, an air gap is introduced into the iron of the bond. Obviously, the reluctance of the air gap considerably reduces the reactance to the alternating signaling current, thus requiring additional signaling current through the bond to maintain the necessary difference of alternating current potential between the rails.

The increased current required by the bond at the relay end of the block causes additional alternating current drop in the rails, which in turn necessitates a higher voltage and more current from the track transformer. Thus, the bond at the transformer receives more current than it otherwise requires in order that the bond at the relay receive enough to maintain sufficient voltage to operate the track relay.

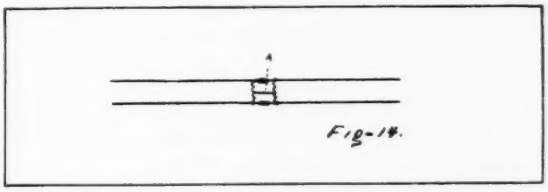


Fig. 14.

For these reasons it is occasionally desirable to place the track transformer in the middle and use a track relay at each end of the block, or an equivalent, and in some respects better arrangement is to use but one track relay having wire-wound field and armature and energize the field from one end of the track circuit and the armature from the other through a small step-up transformer and line wires.

Descriptive Details.

In describing two-rail track circuits in connection with alternating currents, it is with the understanding that both track rails are available for the return of the propulsion current from trains back to power-stations. This has been accomplished where direct current is used for propulsion purposes in several different ways, namely, by cutting the track up into sections, using insulated joints, in practically the same manner as d. c. track circuits on steam roads, which use either storage or primary battery, or by using a jointless type of circuit in which no insulated joints are used, with the exception that joints are placed at the lead rails of cross-overs or turn-outs. Where the track is insulated into sections or blocks, it is therefore necessary to provide a path around the insulated joints for the propulsion current and also make this path immune to the track circuit current. This is accomplished by employing impedance bonds, which may be of two general types, these to be considered as core and coreless bonds, respectively.

Core Bonds.

Core bonds usually consist of eight or more turns of copper conductor of very large carrying capacity, placed around

and insulated from an iron core, the whole being placed in a box and the coils connected to the rails as shown in Fig. 14. Center taps are provided on each bond, by which the rails on each side of the insulated joints are coupled together when the center tap on each bond is connected as shown at "A" in Fig. 10. Cross-bonds may be connected at "A" so as to form a continuous path of low resistance for propulsion currents where there are two or more tracks. By this means the rails are all in multiple for the propulsion current, while they are electrically separated, so to speak, for the track circuits.

It is to be noted that the propulsion current flowing in the two rails passes through the two halves of each bond in opposite directions with the result that it has no magnetic effect on the bond unless more current flows in one rail than in the other, in which case it would have a magnetizing tendency. This if too great, would lower the reactance of the bond, changing its resistance to alternating current and lowering the relay voltage. As this difference of current in the rails, called unbalancing, is likely to occur, the bonds must be designed to take care of this feature. It is done in the following manner. An air gap is maintained between the cores of the bond which makes them much less sensitive to unbalancing on account of the break in the magnetic circuit. It might be well to bear in mind that this air gap also effects the reactance of the bonds as the reactance increases when the cores are brought nearer together and lessens as the cores are separated. If the cores of the bonds were brought together and the propulsion current permitted to flow through it in one direction for a given period, the result would be that the cores would become saturated with d. c. magnetic flux which would destroy the reactance of the bond, while the propulsion current is flowing. The cores are generally built up of sheets of soft iron placed side by side and clamped together, called a laminated core.

If an alternating current is caused to flow through a reactance bond from rail to rail, it will encounter a resistance many times higher than that of the copper contained in the bond. For example, if the ohmic resistance of the bond is approximately .00028 ohms, not including the leads to the rail, the bond having eight turns of copper and an air gap between the cores so set that a reactance of .055 to .06 for 25 cycles a. c. is had, it is readily noted that the resistance

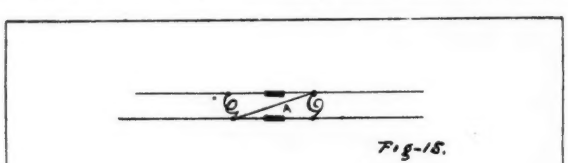


Fig-15.

to the alternating current is approximately 200 times greater than the ohmic resistance encountered by the direct current. The reason for this is that whenever a current is caused to flow through a coil, especially when wound around an iron core, a strong magnetic field is produced which in becoming established produces a counter E. M. F. in the coil which opposes the impressed voltage and delays the building up of the current. If this current is caused to alternate many times a second, it will never have a chance to build up to its full value, i. e., as represented by a constant voltage divided by the ohmic resistance of such circuit, or the a. c. voltage divided by the ohmic resistance of such, hence, the apparent resistance of such current, or, the a. c. voltage divided by the a. c. current will be many times higher than a direct current voltage divided by the resulting current. The more iron or the more turns or both, the more will be this apparent resistance or impedance. Furthermore, the impedence increase with the

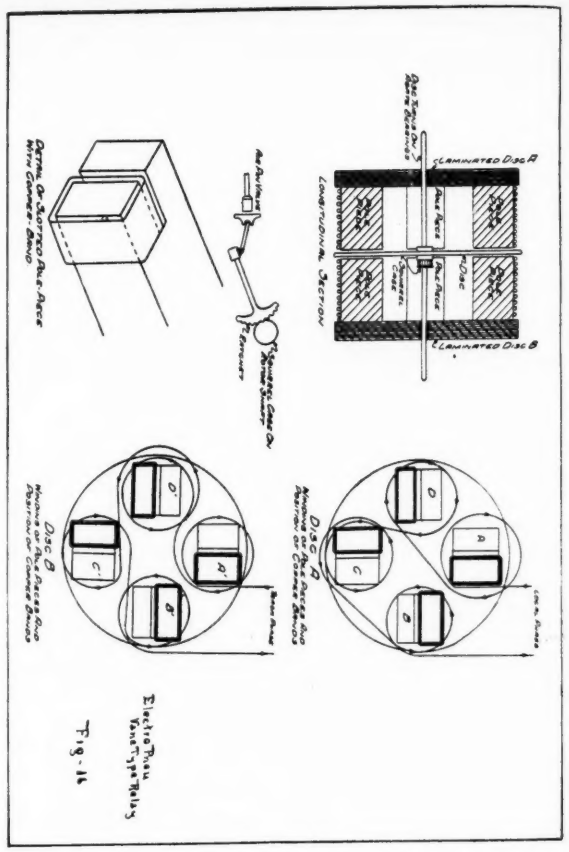


Fig-14

Electric Train Heat Type Relay

frequency; for example, if a bond has an impedance of .06 ohms at 25 cycles it will have an impedence of about .14 ohms at 60 cycles.

Coreless Bonds.

As the name suggests, this bond is made up without an iron core. Flat strips of copper with large cross sections are used, wound in the form of a spiral, the turns being insulated from each other, the coils heavily taped and thoroughly insulated and generally assembled in pairs in boxes. They are connected across the rails in the same manner as the core type of bond, the coils being connected together at the ends instead of the center, as shown in Fig. 15 at "A," this connection making a return path for the propulsion current around the insulated joints. There being no iron core, many more turns of copper must be employed to give the necessary reactance.

Bonds of this type are not susceptible to unbalancing effects as are core bonds. In this type of bond a secondary winding may be placed in inductive relation to the bond and the current induced in the winding used to operate the relay. It will be noted that in doing this an excessive direct current cannot flow through the relay coils, due to the drop caused by the passage of the propulsion current.

Adjacent track circuits may be connected by center taps on adjacent bonds, and when so arranged the secondary coil on bond need not be used. Continuous rails of each track may be cross bonded as often as desired in case broken rail protection is not desired, but when adjacent track circuits are connected by center taps on the bonds, a margin of broken rail protection is afforded on both rails. This type of bond is commercially practical only for roads running light electric traffic, whereas, the core bond is especially adapted for electric roads having heavy traffic.

Track Relays.

At present there are two classes of relays, single phase and polyphase.

Vane Type—Electro-Pneumatic.

The stator is made up of two laminated discs, one on each side of the rotor, each disc having four laminated pole pieces mounted on it, as shown in Fig. 16. The winding of the pole pieces is also shown in the figure. Under normal conditions poles A and C' will be north poles when A' and C are south poles and vice versa, and will, therefore, produce in the rotor a circular eddy current whose center line will be coincident with center line of the respective pole pieces. The direction of flow of this eddy current, however, will be opposite at A to that at C. Each pole piece is slotted and a copper band is placed around one-half of each pole lying in the slot. An eddy current will, therefore, flow through these copper bands, the direction being the same as that of the eddy current opposite to it in the rotor; as the center line of these eddy currents are not the same, they constantly attract each other, tending to come to a common center, and in this way cause the aluminum disc to revolve. The bands on the pole pieces B-B' and D-D' are so placed that when these poles become effective, the tendency is to revolve the rotor in the opposite direction to the tendency created by poles A-A' and C-C', but they are so wound that under normal conditions B-B' are north poles together, D-D' being south poles together, and therefore they have no rotating effect on the disc. In case of a broken down insulated joint which would allow current from another transformer to feed the track phase of the relay, then poles B-B' and D-D' would become effective, A-A' and C-C' at the same time being rendered ineffective; the relay, therefore would be held in the normal position. Motion is transmitted from the revolving aluminum disc through a squirrel cage and sector to a pin valve as shown in Fig. 16. This relay is designed to operate on .5 volts at the relay terminal of the track phase and requires from 8 to 12 amperes of current.

Vane Type—Single Phase.

The principle of operation involved is that of the action of an alternating current field upon a metallic (non-magnetic) vane, which is caused to move in such a way as to close the circuit contacts. The alternating current field is supplied by a magnet of laminated field core construction, with field coils arranged very close to the pole faces. The vane which is of aluminum is pivoted in a vertical position on jewel bearings the upper half of each pole piece is enclosed by a copper ferrule set into a notch.

The ferrule is so arranged that half the lines of force pass through it. Any change in the number of lines of force through the ferrule will set up an E. M. F. in the ferrule acting to produce a current. The direction of this current will be opposite to that producing the change in the field and will itself tend to produce lines of force in opposition to the field. In other words, change from zero lines of force to maximum and back to zero which will be retarded in the "shaded" or ferrule, enclosed half of the field. This will cause the magnetic flux to shift from the lower to the upper portion of the field at each reversal of polarity.

Currents are generated in the vane by the field flux the same as in the ferrule. These currents will produce fields of their own opposite to the main field, and will act against the main field and be repelled by it in the same manner as like magnetic poles but the shifting flux in the main field due to the ferrules is constantly moving upward. Therefore, the vane being raised, the action is similar to that between fields and squirrel cage armature in the polyphase relay.

Frequency Type.

There are three types; one of these has but one winding and two sets of poles in which the selection between frequencies is accomplished by the difference in flux in the two sets of poles, both of which act upon the same vane. In another type there are two coils and two independent sets of poles acting upon the same vane in which the respective amounts of currents in the coils of the two electro-magnets are varied by the frequency and since these magnets act in opposition upon the same vane, the latter will rotate in response to the stronger set of poles. The other type is that of the centrifugal ball arrangement. When energized the rotating element of this relay is in constant motion. Since the speed of the rotation varies as the frequency and force exerted by the centrifugal balls is in proportion to the square of the speeds, it is evident that the adjustment may be made such that at 25 cycles the contacts will not close, but at 60 cycles they will close.

Polyphase—Induction Type.

In a relay of this type a stator and rotor are employed, the stator having two windings, one of which is energized locally from a secondary winding on a transformer which may be direct connected and continuously energized, or it may be in line controlled as required and the energy supply controlled through relay contacts or circuit breakers. The other winding is connected to the track and suitable resistance and impedance placed in the circuit give the right phase relation between the two windings to causing the rotor to rotate which will close the necessary contacts. This relay can also be designed and used as a three-position relay for wireless or polarized circuits.

Polyphase—Wire-Wound Armature.

Field coils are mounted on laminated pole pieces and the armature is wire wound. The operation of the contacts is dependent on the phase relation of the current in the field and armature winding. It is in effect a motor whose armature makes but a part of a revolution and whose field and armature are connected in multiple or excited from separate sources. The operation of such a motor is at once evident when direct current is used and the only difference when alternating current is used is that if the zero value of the current in one element occurs when the maximum value of the current exists in the one element, there is no tendency of the armature to rotat. As the phases of the currents in the two elements approach the point when the zero values occur simultaneously, the torque of the motor increases, being the maximum when this point is reached.

It may be used as a track relay where d. c. propulsion is used with double rail return, or as a line relay when the armature and field windings are connected in series. They are generally wound for higher voltages.

Galvanometer Type.

This relay may be used on either the track or the line, but its chief advantage is secured when used as a track relay. It has two windings; one on the field or stationary element and one on the armature or movable element. The fixtures produced by the current in the two windings are mutually effective to produce torque, and this torque is proportional to the product of the two fluxes. For this reason the relay is especially advantageous in connection with a. c. track circuits because most of the flux producing the torque can be secured by one winding, the current in which does not traverse the track rails, but is supplied locally and the lesser amount of flux by the winding connected to the rails. This results in a small total amount of energy per block and makes practically an a. c. track circuit of a mile or more in length. The relay responds only when the currents in the field and armature are of like character. The relay is made for either two or three positions.

By changing the phase (polarity) of the current supplied to the track circuit 180 degrees by the usual pole-changer (polarity of the field remaining constant), the relay armature is made to rotate in either direction and thus operate the distant signals without the use of wires between home and distant signals. When the block is occupied the armature takes an intermediate position by gravity in which position

all contacts are open. It is ordinarily equipped with four front and four back non-independent contacts.

Line Transformers.

Line transformers (oil cooled) are similar to the standard commercial lighting transformers with the exception that in some designs ground shields are used between primary and secondary windings and are grounded to the case. Grounding of the neutral on the secondary windings does not give desired results where a main common is used, for the reason that if one side of the line were opened an increased voltage would be the result, due to one-half of the winding where line is open being in series with the secondary of the other transformers on the line.

Track transformers are designed with either an open or closed magnetic circuit. The open magnetic circuit transformer is in general use for single-rail track circuits on account of saturation due to the possibility of d. c. propulsion current being shunted through the transformer on account of inter-rail potential between the signal rail and the rail used for propulsion purposes. It is good practice to fuse the wires leading from the track to the transformers.

Transformers with closed magnetic circuits are used on two-rail track circuits. Suitable resistances are used in either single or double rail circuits to reduce the energy consumption when the track is short circuited. These may be resistance units or cast grids as desired.

(To be continued.)

A system of steam pipes is utilized at the New Jersey Terminal of the Erie Railroad to keep the switches clear of snow. The steam is led from the power house in the yard through a 2-in. main, and is carried by 1-in. pipes to each switch, two lines of pipe being placed between the ties under the switch points. During the severe storms of last winter, the operating of the terminal interlocking system was uninterrupted. The snow melts as it falls, and no attention to the switch points is required.

In General

Collapsible Steel Forms.

Six years ago the steel form was commercially unknown—today every up-to-date engineer and contractor uses steel forms on every contract where centering is required. The "Blaw system" is said to be the pioneer method of steel centering. The Blaw Collapsible Steel Centering Co. has devoted itself exclusively during the past six years to the designing and building of steel forms for concrete construction.

The steel form is on the market as a permanent tool for the contractor. When the steel form is used there is no repairing of centers, for the reason that the form is practically indestructible. The contractor gets an absolutely uniform conduit throughout because of the rigidity of the center. With the "Blaw system" the contractor is able to work more quickly, with fewer men and without the use of skilled laborers. The steel form leaves the surface of the conduit smooth; no re-finishing is necessary. With the use of the steel form, winter work is practicable for the reason that the form can be heated internally.

The Blaw Co. not only manufactures forms for every conceivable kind of work from the smallest concrete culvert to the largest concrete sewers, but also for subway construction, the construction of retaining walls, the lining of mine shafts and tunnels, and for the building of concrete silos, concrete columns and beams, concrete chimneys, etc. The Blaw Co. further manufactures forms for cement pipe molds, large collapsible steel ribs for large span arches, caisson forms, manhole forms and sidewalk forms. They manufacture also tapered bolts used in connecting forms while concreting is in progress; carriages for the economical movement of centers; steel bulkheads to do away with the old wood bulkhead idea; steel concrete hoppers; steel flumes for diverting water while sewerage construction is in progress, and other appliances.

The "Blaw system" of centering has been used on some of the largest projects of concrete construction, not only in the United States, but in Canada, Great Britain, Egypt, Central America and South America; also by many of the large corporations of the United States, such as the United States Steel Co., Standard Oil Co., Edison Electric Light Co., Ludlow Manufacturing Associates, Jones & Laughlin Steel Co., Hudson Companies and others, all of whom have found the apparatus of value. Many of the large railroads of the United States are using these forms, not only on the construction of small culverts and for sewerage work in general, but also for large span arches and for the building of retaining walls. The United States government has made use of these forms through the reclamation service, on government work at Washington, D. C., and on the Panama Canal.

Recovering Cement From Empty Sacks.

An investigation has recently been conducted by the Aberthaw Construction Co., of Boston, Mass., relative to the economy of treating empty cement sacks to recover cement adhering to them before bundling for return shipment. Instructions were sent to a number of jobs to have the man who was bundling the bags stretch each one over two sticks, mouth down, and then beat well. The cement was collected in a box. A careful account was kept of the number of bags shaken, the amount of cement saved, and the amount of the man's wages. Strength tests were made on the recovered strength, as it was probable that dirt or other foreign substances might be mixed with it. The total number of bags reported was 7,598; the amount of cement saved, 4,130 pounds. The cost of shaking, bundling and tagging the above bags was $22.44, or about one-third more than the average cost of bundling and tagging without shaking. Hence the net cost of the cement saved was $7.48.

Comparative tests were made of the tensile strength of the shakings and fresh cement from the same lots. An average of these tests showed a loss of 59 per cent in strength after a 24-hour set, but a loss of only 35½ per cent after a 7-day set. On the basis of this last figure, the 4,130 pounds of shaken cement is equivalent to 2,664 pounds of fresh cement. At 380 pounds to the barrel, there was an equivalent of seven barrels of fresh cement recovered. The average price paid for cement on these jobs was $1.41, so the value of the recovered cement was $9.87.

There is a further consideration, however, and that is the saving in freight on the cement shaken from the bags. The average freight paid for returning the bags from these jobs was 24 cents per hundred pounds, which would amount to $10.91 on 4,130 pounds.

The total amount saved is consequently $20.78, which was accomplished with an extra expenditure of $7.48, the net saving being $13.30, or 17½ cents per 100 bags.—*The Contractor.*

The Long Island railroad has just distributed $450.00 in premiums among those supervisors and section foremen whose divisions have been kept in the most perfect condition during the year.

The awards were distributed after the annual track inspection, the president, general superintendent, chief en-

gineer, and engineer maintenance of way, together with officials of other railroads, deciding who should receive them. The first prize, for the best supervisor's division, went to supervisor Frank Turner of the Montauk division, the second to supervisor C. King of the Far Rockaway branch. The following premiums, amounting to $50 for first and $25 for second, for the best sections on each of the divisions, have been awarded to the following foremen: Division No. 1, first premium, Frank Farrole; second premium, Michael White. Division No. 2, first premium, Patrick Burke; second premium, Frank Generla. Division No. 3, first premium, Jacob Reichert; second premium, Guisseppe Cafarelli. Division No. 4, first premium, George Hirsch; second premium, James J. Murphy.

For the tunnel alarms (for transmitting signals indicating fire and for cutting off current to the power rails), in the Pennsylvania Station, New York, there are 116 boxes divided into six circuits, each box having two levers, one marked "Power" and the other "Fire," the "Power" lever automatically cutting off all power current in the section directly affected. This signal consists of two rounds of the box number. The "Fire" lever also automatically cuts off the power current and is indicated by four rounds of the box number.

The watchmen's service is recorded on two portable watchman's clocks from 38 stations, and provides for hourly tours. At the present time there are two watchmen.

A rough estimate of the fire loss in the national forests in Montana and northern Idaho, made by the Department of Agriculture, puts the total amount of timber killed or destroyed in this one district at over six billion board feet, while the area burned over is put at over 1¼ million acres. A large part of the losses on the Coeur d'Alene, Clearwater, and Lolo forests were due to what became practically one great fire. The burn is shown on the forest service maps as extending in a northwesterly and southeasterly direction from north of Wallace, Idaho, to a point some 30 miles southwest of Missoula, Mont., or nearly 100 miles. At its widest point this burn has a width of about 40 miles, but its shape is very irregular. It was really a union of a number of separate fires, driven to fury by the fierce hurricane of August 26. To the west of the Idaho-Montana boundary in the region of this fire lies a very inaccessible mountainous country, into which, on account of the absence of trails and of forage, it was almost impossible for forces of fire fighters to penetrate. When the hurricane arose it drove the fires upon the parties which were hewing a way towards them, forced these parties to seek refuge wherever it could be had, and swept down upon the forests where the fires were up to that time generally well in hand. The extensive losses are ascribed to the combination of hurricane and lack of means to get to the fires and put them out before the storm came. On the forests which were best equipped for controlling fires the results achieved are regarded as a demonstration of the efficacy of the fire-fighting methods employed, even under highly adverse natural conditions. Forester Graves believes that, as usually happens in the case of big fires, there will be found to be considerable areas of living timber within the regions now mapped as entirely burned over. There will be an enormous quantity of fire-killed timber, both on the national forests and on private lands, to be disposed of as soon as possible, since if not marketed quickly it will not be worth cutting at all.

Since the amount to be disposed of from government lands is doubtless greater than can be marketed in any event, and since it is better for the country that the timber should be utilized than that it should go to waste in the woods, the price at which it will be sold will be lower than would be asked for the timber under ordinary circumstances.

If the six billion feet were a total loss, and if its stumpage value was put at the average price at which national forest timber was sold last year, it would be the equivalent of a money loss of about 17 million dollars. It is believed that this year's fires either burned up or killed between 1 and 2 per cent of the total stand of national forest timber. At the present rate of cutting from the national forests, six billion feet is equal to 12 years' supply; but it is less than one-sixth of a single year's cut in the entire country.

In an action for fire trespass on the Black Hills National Forest brought by the United States against the Missouri River & Northwestern, the jury has awarded damages to the government not only for the loss of merchantable timber, but also for the destruction of unmerchantable young growth. So far as is known, this is the first time that any court has recognized what foresters call the "expectation value" of young growth as furnishing a basis for the award of damages. The difficulty in the way of such an award in the past has been that there was no way to prove to the satisfaction of the courts the money value of the loss suffered. The award in the South Dakota case followed the presentation of evidence as to the cost of work in reforesting which the government is actually doing in the Black Hills. The amount claimed for the young growth burned was $12 an acre, and the claim under this item was allowed in full by the jury. The total amount of damages claimed was $3,729, of which $2,634 was for merchantable timber destroyed or injured by the fire.

AUTOMATIC STOPS AND CAB SIGNALS.*

For reasons which have been sufficiently explained, these two devices are naturally considered together. In both of them a vital question is that concerning the efficiency of the means for conveying an impulse from a source fixed on or near the roadway to apparatus carried in or on a moving vehicle. It is in the light of this fact that the Railway Signal Association has formulated "requisites of installation," setting forth the conditions which it is held must be complied with in order to provide either a stop or a cab signal system which shall be satisfactory. These requisites, as conditionally approved at the annual meeting of the Railway Signal Association, in 1908, were given in our last report, page 22. This conditional approval was confirmed by the active members of the association in a letter ballot in January, 1909, by a four-fifths vote; but at the annual meeting of the association this year (Louisville, Oct. 14, 1909) the subject was reopened, and from the discussion which took place at that time it would appear that the attitude of the association can hardly be looked upon as being so well defined and well settled as might appear from a study of the "requisites." The action of the association must be considered in the light of the fact that, with very few exceptions, the members doubtless look upon the question of automatic stops and cab signals as one which need not be taken up, except as a theory, until some time in the more or less distant future.

AUTOMATIC STOPS.

As has been set forth in previous reports, the principal question to be dealt with by this board in connection with automatic stops is that concerning their applicability to the varied conditions of general railroad traffic and their behavior under adverse weather conditions. The stops in use on underground and elevated railroads, never seriously interfered with by drifting snow or by sleet and ice, throw little light on this problem. Four installations on surface railroads have received the attention of the board during the year, two of which, however, were not in complete shape.

The devices of the Rowell-Potter Safety Stop Company were installed in October, 1908, on 5 miles of the Chicago, Burlington & Quincy single-track line between Sugar Grove and Big Rock,

*Report of Block Signal and Train Control Board.

Ill., and on 2 miles of the double-track line of the same company east of Aurora, Ill. Two locomotives used in local freight service were fitted with the apparatus to apply the air brakes. These engines were in regular service throughout the winter, and the inspector of the board observed the behavior of the apparatus in cold weather and at times when there was deep snow on and around the ground apparatus. The Rowell-Potter train stop is a mechanical trip. A bar lying parallel and close to one of the rails of the track is lifted a short distance above the rail, whenever the visual signal is set in the stop position; and this bar, coming in contact with an air-brake valve (suspended from the equalizer of one of the trucks of the tender) opens the valve and applies the brakes. Bars at the side of the track are provided in duplicate at each signal location, the two being rigidly connected to each other in such a way that one bar must always be in engaging position (to stop a train) and the other depressed. One is 180 feet in advance of the other, and if the first one fails to go to the stop position behind a passing locomotive, the second one remains up and stops the train. Power to operate the stop as well as to operate the semaphore signals of the system is derived from the pressure of the wheels of passing trains on levers fixed close to the rails, these levers serving to wind up a coil spring. This power apparatus is one of the principal features of the Rowell-Potter system as presented. Track circuit control is provided as in ordinary automatic block signaling.

The board has summarized the reports of the inspection of this apparatus during the winter that it was under observation and has expressed its opinion to the proprietors in substance as follows: The power-storing machine is generally of good design and has given as good results as could be expected from a new machine; and as regards safety, a regular installation would, it is believed, merit approval. But the advantage claimed for this machine over other means of producing power is in economy, and on this point no satisfactory data are available. This board can consider the question of economy only as it relates to safety.

The semaphore signals in this system require power to restore them to the stop position. While the use of duplicate track trips would insure the stoppage of a train in the event of its passing a signal which was improperly stuck at clear, the system would be more commendable if the power machine were used only for clearing the signals and if they were arranged to assume the stop position by gravity.

The design of the mechanical-trip train stops is commended. They are subjected to such severe shocks that springs, primarily undesirable, are used in their connections, but the arrangement seems to be sufficiently safeguarded against a failure of the stop from a breakage of a spring. The engine air-brake valve has given fairly satisfactory service, but in the design, as used, air pressure tends to hold the valve closed; it ought to tend to open it.

As regards the system as a whole, the board concludes that if the faults mentioned (in the report) were remedied, and it sees no reason why they should not be substantially overcome, and if the apparatus were well inspected and maintained, the system would be safe and reliable, and its use would tend materially to promote safety of operation on a railroad using it. As to its economy, there is insufficient data to form a conclusion of any real value. (See appendix for further details and for description of apparatus.)

S. H. Harrington's automatic stop has been in use in connection with one signal on the Northern Railroad of New Jersey over two years, and with seven signals on the same line about fourteen months. This stop has been carefully watched by the proprietor's inspectors, and he has presented to the board a summary of their reports. Unlike any other well-developed device brought before the board, this stop works "overhead"; that is to say, the device fixed at the roadside is suspended, about 15 feet above the track, in such a way as to come into contact with a projecting arm of an air-brake valve on the top of the cab of the locomotive, the opening of which valve applies the brakes. The roadside device consists of a short iron bar suspended in a vertical position, loosely, by a chain; and it is of such size and weight as to cause the movement of the lever on the locomotive cab by its inertia alone, without being rigidly fastened to its support. As before stated, the board expects to detail an inspector to watch the operation of the Harrington stop during the coming winter.

The Perry-Prentice apparatus, referred to in our last report, has been further examined. In this the actuation of the stopping device (or a visual or audible signal) on a moving vehicle is effected by Hertzian waves, having their source in the currents in a line wire strung on poles at the side of the railroad and acting through the atmosphere without metallic connection from line wire to vehicle. This apparatus was tried on the line of the Suburban Railroad Company, an electric line between Chicago and La Grange, Ill. In the experiments witnessed the function of the Hertzian wave apparatus—which embodies a principle not before used in railroad signalling—was performed in a manner warranting the encouragement of further experiments whenever a more complete installation shall be made.

The Simmen Automatic Signal Company, which more than a year ago proposed to install automatic stopping apparatus and laid plans before the board, has made an installation of some of its apparatus on the Atchison, Topeka & Santa Fe Railway between Highgrove and Perris, Cal., the length of road equipped being about 18 miles; and also on about 10 miles of the Toronto & York Radial Railway, an electric line running westward from Toronto, Ontario; but neither of these installations is provided with the automatic stop feature. The device works by means of an electrical contact. In the Toronto installation, which has been examined by members of the board, there are contact bars or rails at each signaling point, and these are used for conveying an electric current from the dispatcher's office to lights in the motorman's cab in such a way as to give the motorman "proceed" or "stop" signals by green or red lights. Alongside of the lights in the cab are a telephone and a bell, and telephone messages are exchanged between the dispatcher and the motorman over the same circuit that is used to control the lights, that is to say, the line wire from the dispatcher's office (a wire to each station), the contact bar and the connections from the bar to the apparatus in the cab. The cab signal in this Toronto installation is a part of a dispatching system, not a block system. One man, the dispatcher, performs the signaling operations for each and every station or signaling point. He gives to the motormen their instructions to proceed from station to station by means of lights, and also confirms this by speaking over the telephone. The levers or circuit closers by which the signals are sent over the circuits to the different signaling points are interlocked so as to prevent the giving of conflicting signals; but the details of this interlocking apparatus have not been laid before the board. The use of the Toronto installation during last winter afforded some little experience in the management of the contact bars at the signaling points in cold weather; but on the question of the behavior of such contacts where trains are run at high speed little light was thrown.

A train-control system, embodying the use of short sections of track rail made of nonmagnetic steel, has been presented to the board. This system has been held to possess merit warranting the board in encouraging the proprietors to develop it practically, and in testing it under operating conditions if a satisfactory installation for that purpose is offered.

CAB SIGNALS.

As was noted in our last report, automatic stop apparatus is used in America (New York, Boston, and Philadelphia), while cab signals are used in France and, to a limited extent, in England. There are no cab signals in America and no automatic stops in Europe (except on the London underground lines, where the conditions are similar to those in New York).

The only cab signal used in connection with an approved block system that has received the attention of the board during the past year is that on the Great Western Railway of England, which was described in our last annual report, pages 14 and 36. From Mr. A. T. Blackall, the signal engineer of the Great Western Railway, we have received a record of the behavior of these stops during the twenty-one months ending September 30 last.

"The signal has been used on the locomotives of the Fairford branch of the Great Western three years. Mr. Blackall writes that very little trouble has been experienced with frost and none with snow, the contact shoes on the engines being heated in cold weather by steam. These signals are used in place of the fixed visual distant signals, and the distant semaphores have been taken out of service. There are on the Fairford line an average of 5,650 signal operations a year. A record is kept of every irregularity. These during the twelve months of 1908 and the first nine months of 1909 were as follows:

	Bell instead of whistle.	Neither bell nor whistle.	Both bell and whistle.	Whistle instead of neutral.	Whistle independently of ramps.
1908.					
January	.....	.....	.....	4	1
February	.....	1	1	3	.....
March	.....	.....	.....	3	.....
April	.....	1	2	1	.....
May	.....	.....	1	3	.....
June	.....	.....	.....	3	.....
July	.....	.....	.....	.....	.....
August	.....	.....	.....	2	.....
September	.....	.....	.....	3	.....
October	.....	.....	.....	.....	.....
November	.....	.....	.....	1	.....
December	.....	.....	.....	3	.....
1909.					
January	.....	.....	3	6	.....
February	.....	.....	.....	2	.....
March	.....	.....	2	1	.....
April	.....	1	1	.....	.....
May	.....	1	.....	1	.....
June	.....	.....	.....	1	.....
July	.....	.....	.....	.....	.....
August	.....	.....	.....	.....	.....
September	.....	.....	.....	1	.....

"It will be observed that during the whole twelve months there was not a single case of a false 'clear' signal; in fact, says Mr. Blackall, there has not at any time been such a case, either on the Fairford line or on the main line.

"The causes of the failures have been various. The four cases in which neither bell nor whistle was received were bell failures; that is to say, the line was clear and the operation of the danger signal was duly and properly suppressed, but the bell failed. Two failures were caused by something on the engine getting in contact with the shoe and so short-circuiting the electro-magnet connected with the shoe; two or three cases were due to frost. There was one case of a broken wire and another due to a defective battery.

"Since our report of a year ago 76 signaling ramps have been installed on the main line between Reading and Slough. Twenty-one engines are fitted with the cab apparatus. No record has been made of the number of signal operations on the main line, although a record is kept of all failures.

"The design of the cab apparatus on the main-line engines has been somewhat modified from that originally installed on the Fairford line. Instead of the current picked up directly energizing the electro-magnet for keeping the whistle closed, current from the line operates a polarized relay on the engine, which keps the whistle closed by means of a local circuit."

The Rowell-Potter Train Stop.

Power-storing Motor With Selector for Single Track.

Figs. 1, 2 and 3.

A—Is the frame of the machine.

B—Is the cylinder inclosing power springs, to which one end of the springs is attached.

C—Is the main shaft extending through the axis of the cylinder to which the other end of the springs is attached.

D—Is the governor shaft which governs the winding of the springs and through which the power of the springs is transmitted to the signal mechanism.

E—Is the hollow shaft which is screwed on and off D by the winding and unwinding of the springs.

F—Is the winding rack meshed with G. Its lower end is connected to lever F2.

G—Is gear fastened to ring H containing dogs which rotate cylinder B by the upward movement of F and winds springs.

I—Is the frame in which retaining dogs are confined to prevent the force of the springs from turning the cylinder backward during the downward movement of F.

J—Is the ratchet ring fastened to cylinder B in the teeth of which the dogs contained in H and I operate.

K—Is the link connection from crank on D to arm on rock shaft L.

L—Is rock shaft which transmits power to bar M in selector box and also drives L, in the opposite direction through the medium of gear segments L", which moves bar N in the opposite direction to that of M.

O—Is signal bar for blade in one direction (west.)

P—Is signal bar in the opposite direction (east).

Q—Is the driving bar connected to pipe line which moves the track instruments.

R—Is the sprocket wheel fastened to main shaft C.

S—Is gear fast to end of cylinder B.

T—Is the gear on E through which E can slide longitudinally, but is compelled to rotate with it by means of a feather.

30—Is cut-out trigger.

31—Is rod connection from 30 to 33.

32—Is locking dog which locks 33 away from rack F.

33—Is dog which, when engaged with teeth on F, holds it in the elevated position.

34—Is the rod connection from 30 to 32.

35—Is the spring on 31.

36—Is back-lock finger.

37—Is fulcrum pin of 30.

SELECTOR MECHANISM.

1—Is the cylinder inclosing power springs, one end of which is attached to it, for driving selector.

2—Is the main shaft extending through the cylinder to which the other end of the springs are attached.

3—Is the governor shaft.

4—Is the hollow shaft screwed on and off 3 as the springs are wound and unwound.

5—Is the shaft with sprocket wheel on one end and ratchet ring on the other. Dogs 6 engage with the teeth of this ratchet and rotate cylinder A to wind the springs.

7—Is the gear keyed to shaft 2.

8—Is the gear keyed to shaft 3.

9—Is the hollow gear containing a coil spring, one end is fast to the gear and the other fast to shaft 10.

10—Is the latch shaft.

11, 11—Are small gears introduced between two parts of 10 for the purpose of changing its motion.

12—Are locking disks keyed to shaft 3.

13—Are sliding lock bolts operated by eccentrics on shaft 10.

14—Is a gear through which 4 can slide longitudinally but is compelled to rotate with it because of a feather.

15—Is cut-out lever which is operated by the movement of 4 and swings ring 16 into or out of the path of dogs 6, causing

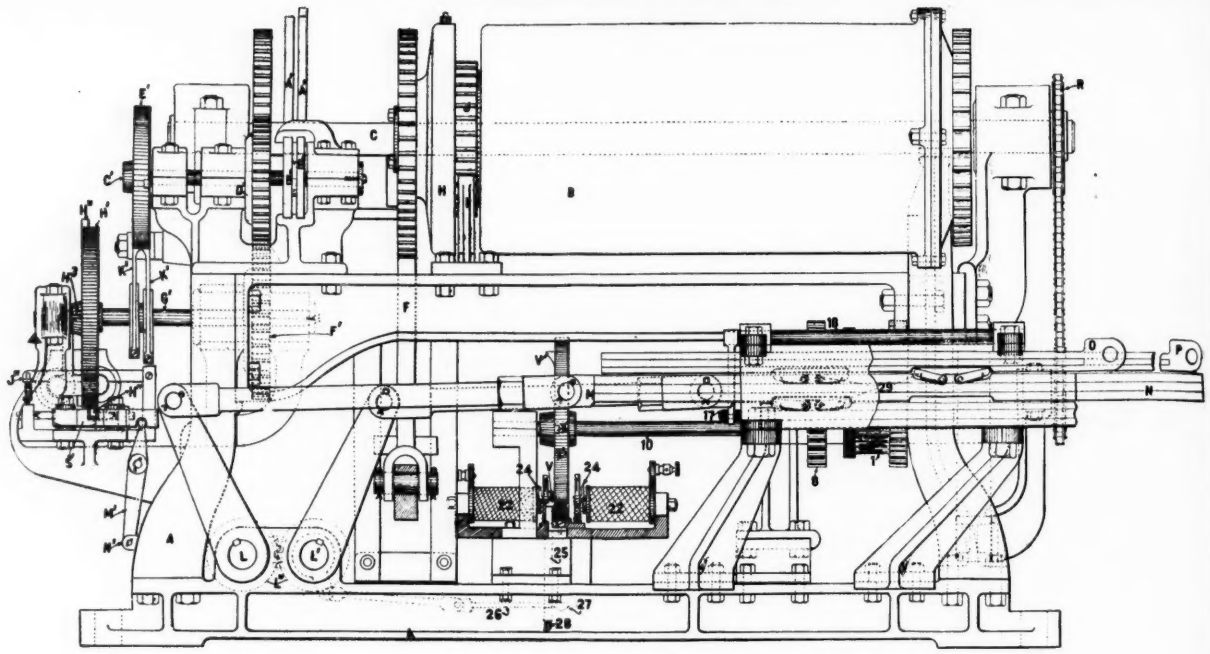


Fig. 1. Power Storing Motor.

them to engage or disengage with ratchet teeth on shaft 5.

17—Is link connection between crank on shaft 3 of selector to shaft 18 in selector box.

19—Are slides worked up and down alternately by the rocking of 18.

20—Is link connection from crank on shaft 3 to circuit-breaker box.

21—Is locking wheel on shaft 10. It has on its periphery lugs XX and on its face lugs VV.

22, 22—Are electro-magnets.

23—Is an armature common to these magnets.

24—Are right-angle armatures. They lock 23 away from their respective magnets.

25—Is mechanical lock bolt to check momentum of 21.

26—Is link connection between L′ and 27.

27—Is cam slide, the horizontal movement of which forces 25 downward against the pressure of spring 28.

29—Are dogs in selector box, which lock power bars M and N to signal bars O and P and to driving bar Q of track instruments.

Machine-Lock Mechanism.

A′A′—Are lock disks keyed to shaft C.

B′B′—Are locking dogs which are slid into and out of the path of lugs on A′A′ alternately by means of eccentric on shaft C′.

D′—Is hollow gear meshed with gear on main shaft C and containing a coil spring, one end of which is fast to the gear and the inner end fast to shaft C′.

E′—Is wheel fast to shaft C′. It has two lugs E″E″ on its periphery.

F′—Is a duplicate of D′ meshed with gear on main shaft C and has coil spring inside connecting it with shaft G′.

H′—Is wheel keyed to shaft G′. It has two lugs on its periphery H″H″ and also two on the face H3H3 at right angles to those on the periphery.

I′—Is an electro-magnet, and J′ is its armature. J″ is a right-angle armature which locks J′ away from magnet and must be attracted downward before J′ can be moved toward magnet.

K′K′—Are locking fingers which are moved into and out of lugs E″E″ on E′ alternately by eccentrics on G′.

Rowell-Potter Safety Stop Co.
Chicago Ill. March 12, 1909.
Power Machine
Approved B.&.R.

S′—Is mechanical locking bar to take the shock of wheel H′ off the magnet armature and is moved into and out of the path of lugs H″H″ on H′ by the movement of shaft L through the medium of lever M′ and link N′.

O′—Is a mechanical lock which locks the machine in the danger position when the springs are unwound to a predetermined limit. It is operated by the backward movement of E through the medium of lever K′, link Q′ and lever Q″.

Operation.

Assuming that the machine is in the reverse position to that of an approaching train.

The machine being in the reverse position, the pipe line Q would be in the correct position, i. e., the first track instrument in the order of approach, clear, and the second one at danger.

The first electro-magnet 22 in the order of approach is energized; 24 is attracted downward which unlocks 23 and allows it to be attracted and withdrawn from beneath X and into the path of its mate. This allows the spring in 9 to rotate shaft 10, one-half revolution, until lug V on the face of 21 comes in contact with lock bolt 25, which stops it just short of allowing lug X to strike the armature to prevent all shock to the electrical apparatus. 25 is withdrawn from the path of V by the movement of L′ through the medium of 26 and cam slide 27 and is inserted by spring 28. Lock bolt 13 is withdrawn from beneath the lug on 12 and its mate inserted in the path of the opposite lug. The springs in 1 rotate shaft 2 and through the medium of gears 7 and 8 rotate shaft 3 one-half revolution until stopped by lug coming in contact with 13. This movement also rotates gear 9 one-half revolution and restores energy to the spring which was consumed in rotating shaft 10. The movement of shaft 3 rocks shaft 18 in selector box, one of the plates 19 is lowered and the other raised, which arranges the dogs 29 in selector box to clear the proper signal and operate pipe line according to direction of train.

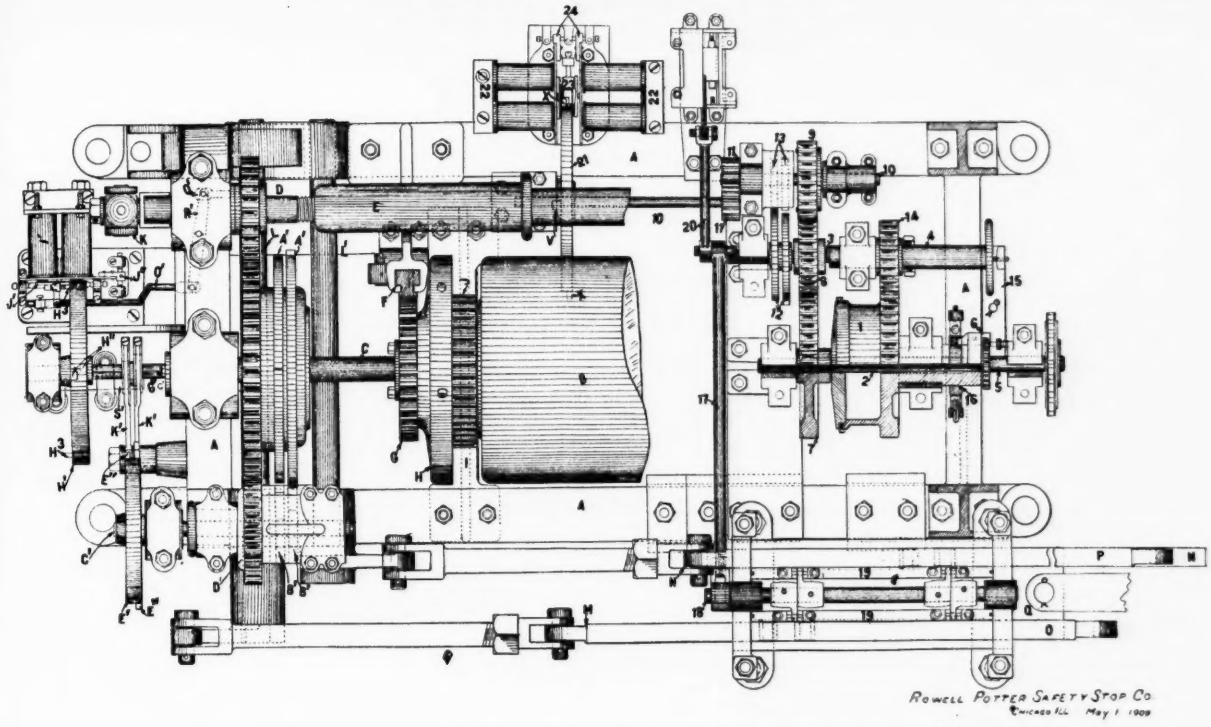


Fig 2. Power Storing Motor with Selector.

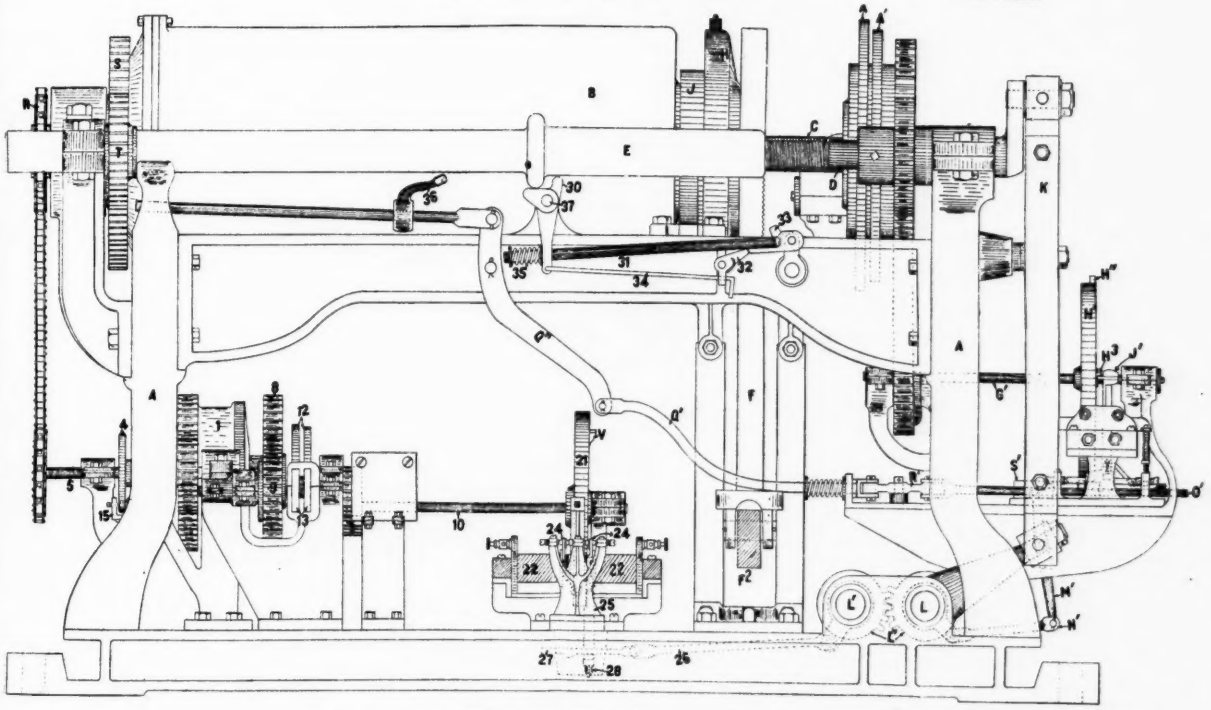


Fig. 3. Power Storing Motor with Lock.

The current is also switched by means of link 20 from magnet 22 of the selector to magnet I′ of machine lock.

Armature J″ is attracted downward, J′ is withdrawn from beneath H3 and into the path of its mate. The spring in F1 rotates shaft G1 one-half revolution until lug H″ on H′ strikes lock bolt S′, which stops lug H3 just short of striking armature J′. The eccentric on shaft G′ withdraws one finger K′ from beneath lug E″ on E′ and inserts the other in the path of the opposite lug. The spring in D′ rotates shaft C′ one-half revolution until stopped by lug E″ coming in contact with K′. By means of an eccentric on C′, B is withdrawn from beneath lug on A′ and its mate inserted in the path of the next lug set at ninety degrees.

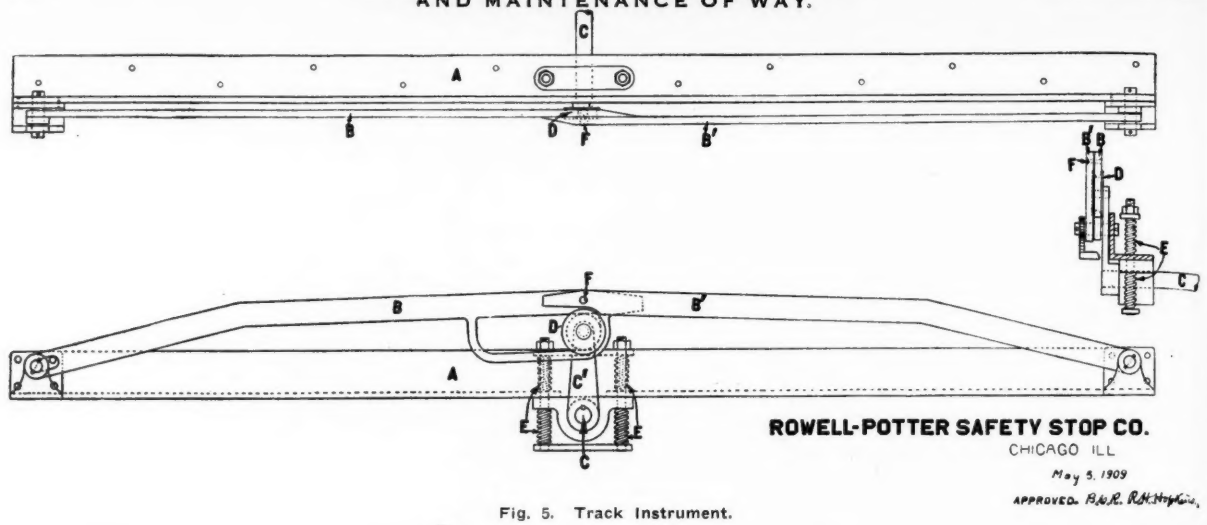


Fig. 5. Track Instrument.

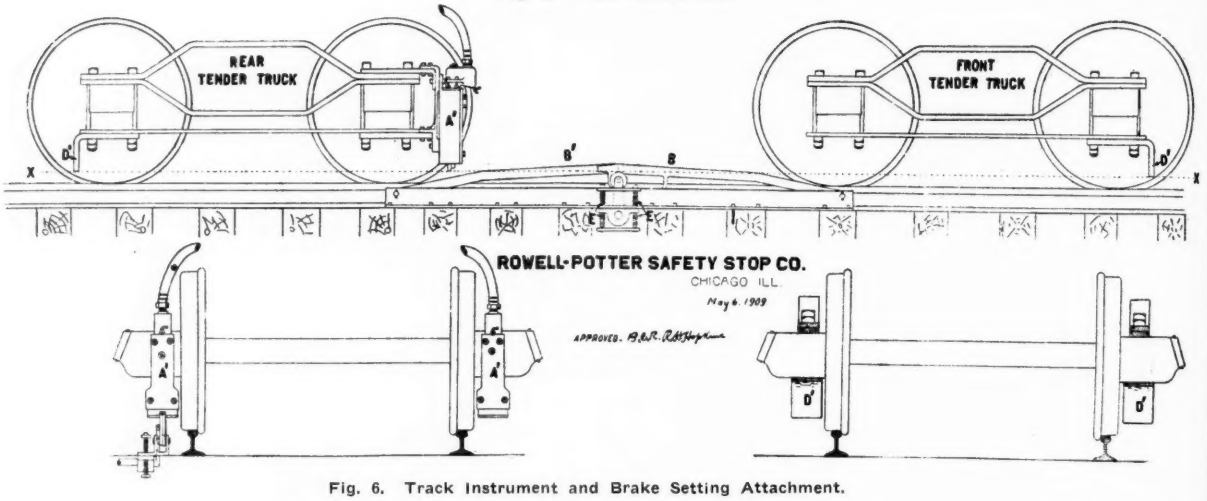


Fig. 6. Track Instrument and Brake Setting Attachment.

The main shaft C makes one-fourth revolution, rotates shaft D one-half revolution, and from this shaft through the medium of link K and rock shafts L and L′ the signal and track instruments are operated. The movement of shaft C rotates gears D′ and F′ and rewinds their springs, which were exhausted in rotating their respective shafts, and also rewinds the selector springs by means of sprocket wheel R and chain.

The movement of rock shaft L removed lock bolt S′ from the path of lug H″ of H′ and allows lug H3 to rest gently on J′. Rock shaft L′ removed bolt 25 from path of lug V on 21 and allows X to rest gently on 23.

The operation above described clears the signal for a train in either direction, according to which magnet of the selector lock the circuit is completed through. The reverse movement, i. e., setting signal at danger, the current is cut off magnets I′ and the operation of the machine is the same with the exception that the selector is not operated.

The winding of the machine is governed as follows:

As cylinder B is rotated, E is screwed onto D by means of gears S and T. When the springs are wound to the proper tension, the ring on E comes into contact with the upward extended finger of 30 and rocks it on its fulcrum 37. This compresses spring 35 until the hook of 34 engages 32 and pulls it out of the path of 31 when the tension of spring 35 shoots 31 forward, and consequently 33, into engagement with the teeth on F.

In unwinding the springs, shaft D is rotated and E is screwed off it. When the springs are unwound to a predetermined amount, the ring on E comes in contact with 36, Q″ is tilted and, through connections Q′ and R′, lock O is operated and the machine locked in the danger position. The machine used on double track, which blocks trains in one direction only, is a duplicate of this with the exception that it has no selector.

Tread-Bar Wind.

Fig. 4.

The tread-bar wind consists of a rock shaft with arms keyed thereto at frequent intervals to support the tread bar. These arms extend under the ball of the rail and prevent the tread bar from extending too high above tread of rail. The center arm is in the form of a long lever F2, which extends back and connects with winding rack of machine.

Track Instrument.

Fig. 5.

A—Is angle bar bolted to the ties.

B and B′—Are a pair of bars which are lapped at the center and joined by pivot F and fulcrumed at their outer ends, B being slotted to allow of raising and lowering. B also has a loop at its inner end in which roll D is confined.

C—Is rock shaft to which C′ is attached .

C′—Is arm, one end keyed to C and the other end carries grooved roll D.

E—Are springs which hold the bearing of C firmly against the base of A. The object of this arrangement is to provide a means of raising bars B B′ in the center to form an incline plane and lower them to a level with the rail. The rotating of shaft C ninety degrees does this. Shaft C has on its outer

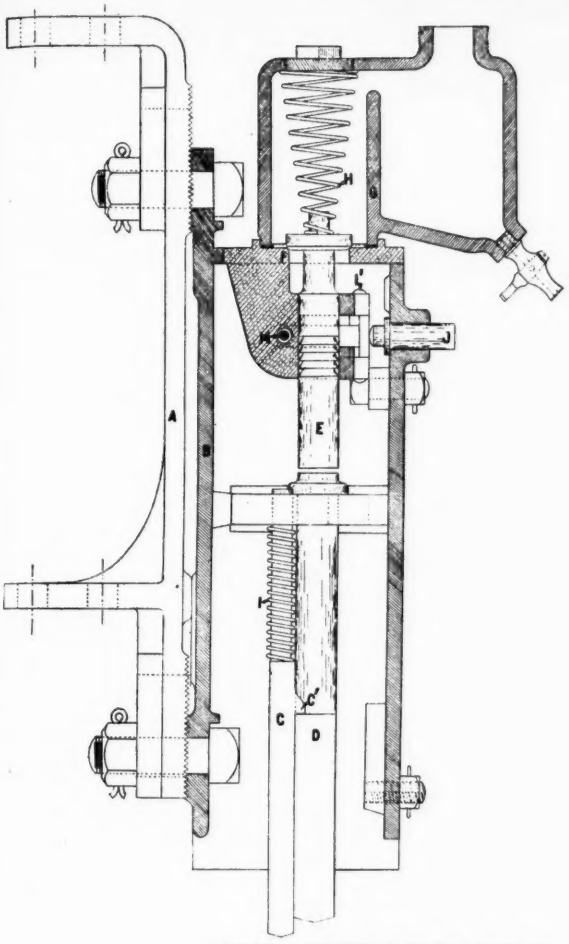


Fig. 7. Engine Machine, Side View.

end an arm (not shown on Fig. 5) to which the pipe line or propelling power is attached.

The object of springs E is to provide a flexible instrument, i. e., a greater load than the sustaining power of springs E being placed upon bars B B′, springs E would be compressed and bars B B′ pressed down instead of being broken. Shaft C has a universal bearing at its outer end to permit of this.

The loop on B for this intsallation was welded; some trouble was caused by poor welds. For permanent service bars B and B′ would be drop forged in solid metal and the character of steel specified.

Fig. 6.

This drawing diagrammatically illustrates brake setting attachments to engines and the track instruments in their relative positions.

A′—Are brake-setting attachments bolted to the forward end of the rear tender truck, one on each side.

B B′—Are track-instrument bars shown and described as Fig. 5.

D′ D′—Are guards for A. They are fastened to the forward end of the front truck and the rear end of the rear truck.

Guards D′ D′ and the plungers of A are tangent to an imaginary line shown dotted as XX, which is parallel to and 3½ inches above rail, so that with the engine running in either direction any obstruction that would injure A′ would first come in contact with one of the guards D′ and be swept from the

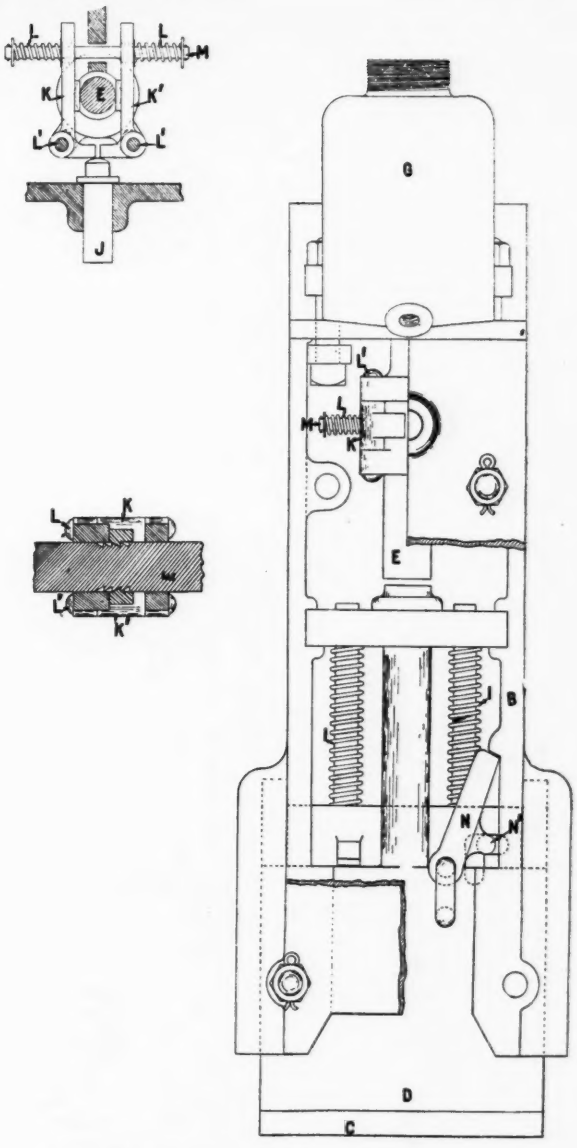


Fig. 8. Engine Machine, Front View.

path of A′. Of course, when B B′ are in the elevated position, they are first struck by D′ and pressed down against the pressure of springs E, but immediately recover, as D′ passes over them and operate A′.

Engine Machine.

Figs. 7 and 8.

A—Is machine hanger which is fastened to the axle box or equalizing bar of the tender truck. It has on its face teeth which mesh with like teeth on B for adjusting the height of machine and relieving the hanger bolt of strain.

B—Is box frame inclosing the moving parts.

C—Is locking plunger which locks main plunger D in its normal position.

C′—Is lug fast to C and resting on top of D.

D—Is main plunger which when raised forces E upward off its seat.

E—Is valve stem.

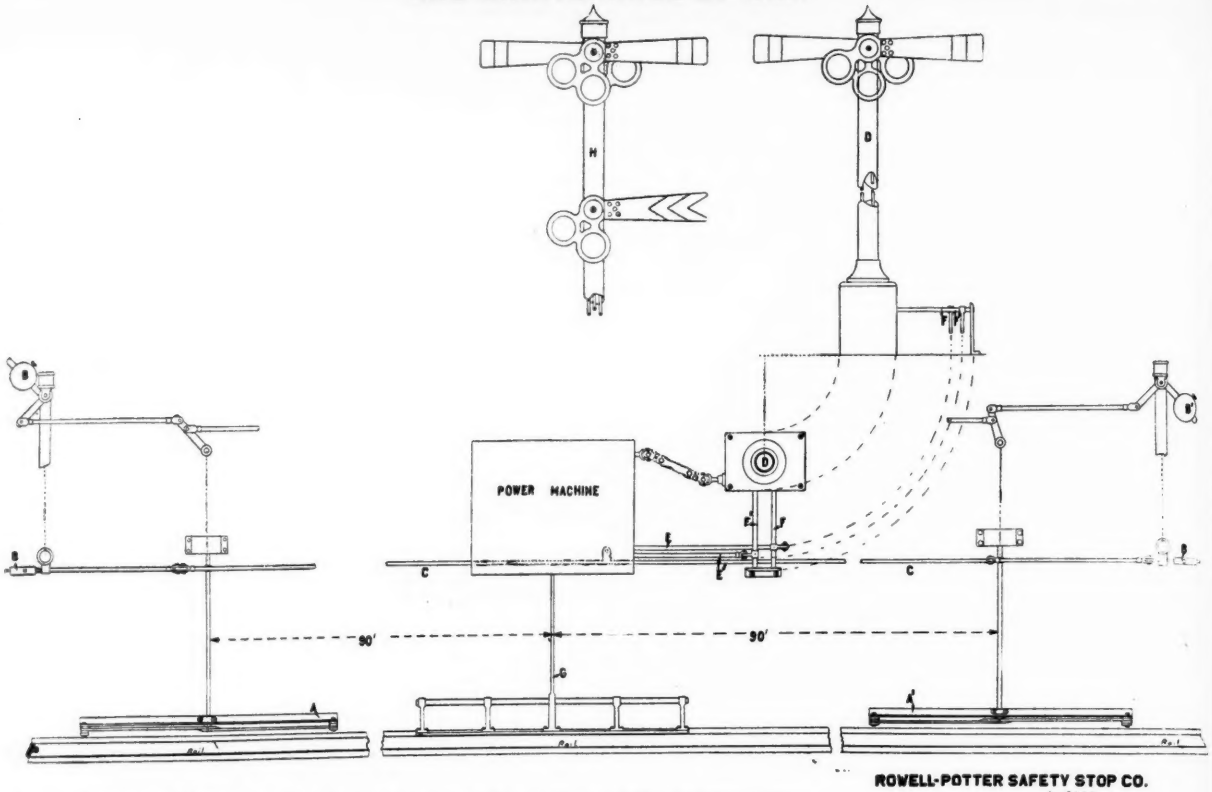
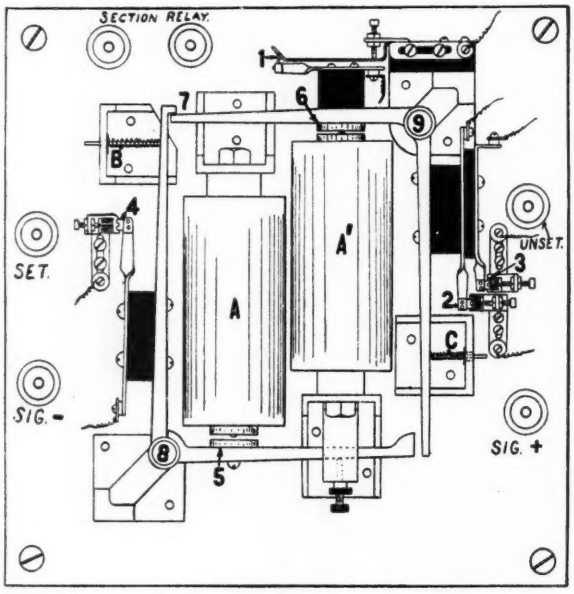


Fig. 9. Diagram of Signal, Showing Relative Positions of Semaphore and Track Instruments.



ROWELL-POTTER SAFETY STOP CO.
CHICAGO ILL

4/9/09

APPROVED-B.&.R. R.H.Hopkins

Fig. 12. Diagram of Single Track Circuits.

F—Is valve seat.

G—Is valve casing; it has two compartments. Air is admitted to the outer compartment and passes over a partition to get to the valve which prevents moisture from getting to valve and freezing.

H—Is conical spring which holds E firmly to its seat.

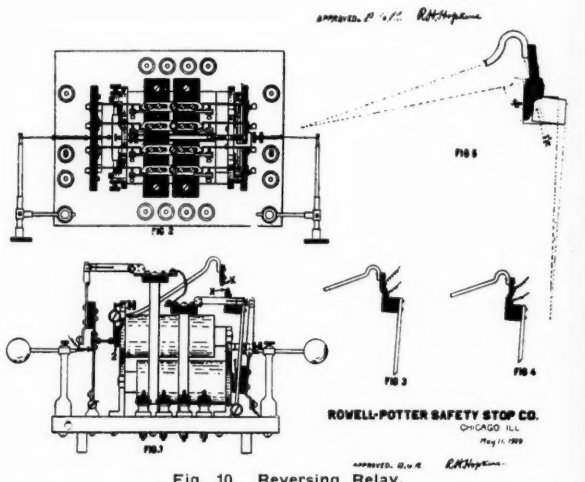


Fig. 10. Reversing Relay.

I—Are springs on C which press it downward and cause C′ to bear hard upon top of D.

J—Is releasing button.

KK′—Are locking fingers in the form of right angle cranks pivoted at L′.

LL—Are springs on M whose strength is exerted to press KK′ together and cause them to bear on either side of E.

M—Is a floating arbor for LL.

N—Is locking dog on D which locks D in its normal position. It has a lug N′ which extends into a right angle slot in C.

Plunger C extends below D the proper distance so that an incline of 1″ in 30″ will raise C a sufficient distance to cause the locked position, as shown on Fig. 8.

The top of slot in C bears upon the top of N′ and holds it in

Operation.

the lower part of slot in C to press upward on N1 and rock N out from under the lug on B before coming in contact with

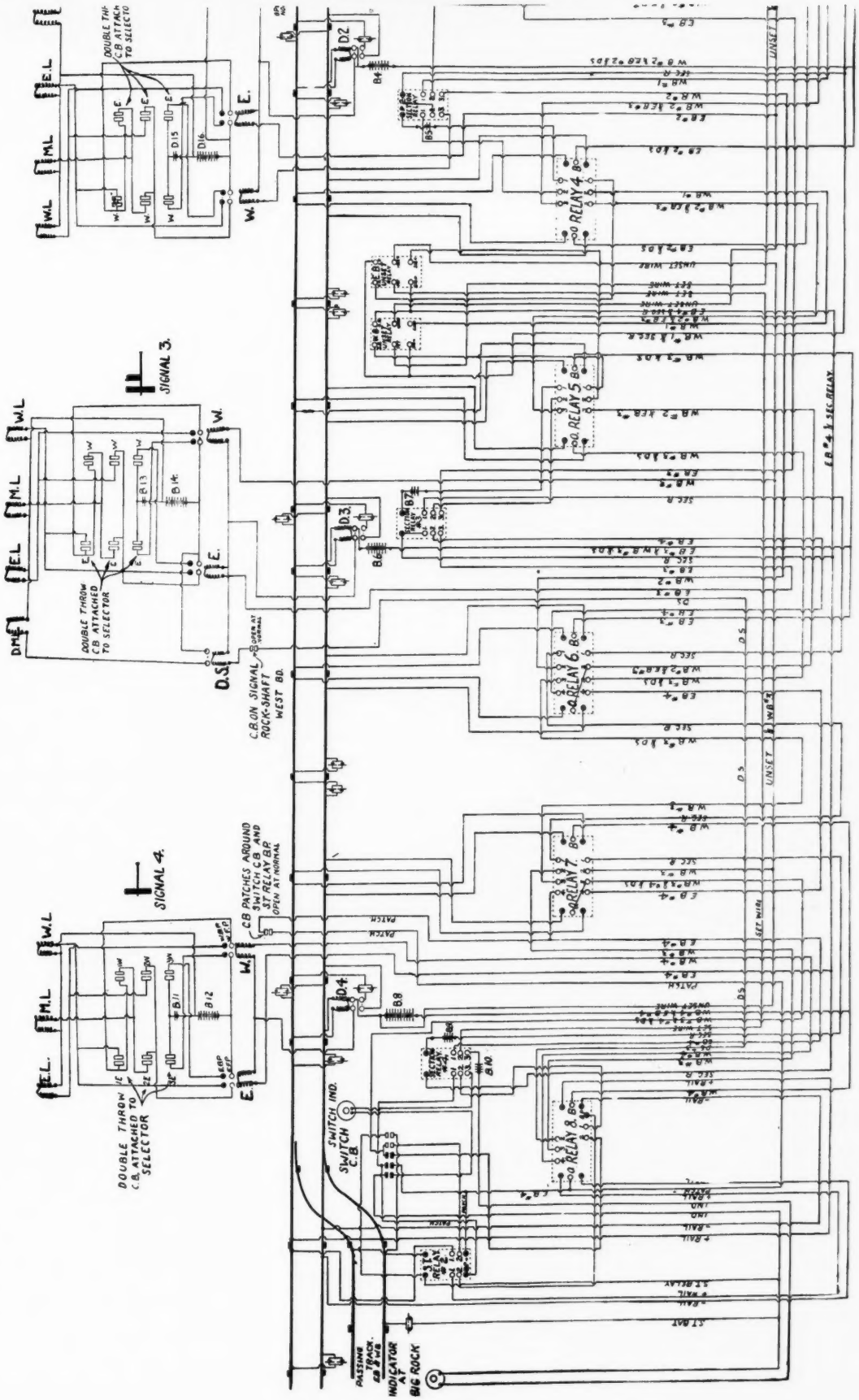

SIGNAL 3.
SIGNAL 4.
DOUBLE THROW C.B. ATTACHED TO SELECTOR
C.B. ON SIGNAL ROCK-SHAFT WEST BO.
C.B. PATCHES AROUND 3 WITCH C.B. AND 3T. RELAY B.P. OPEN AT NORMAL
SWITCH IND. SWITCH C.B.
RELAY 4 BO
RELAY 5 BO
RELAY 6 BO
RELAY 7 BO
RELAY 8 BO
PASSING TRACK 2.3 W.B. INDICATOR AT BIG ROCK
UNSET
PATCH

Fig. 12. Diagrams of Single Track Circuits.

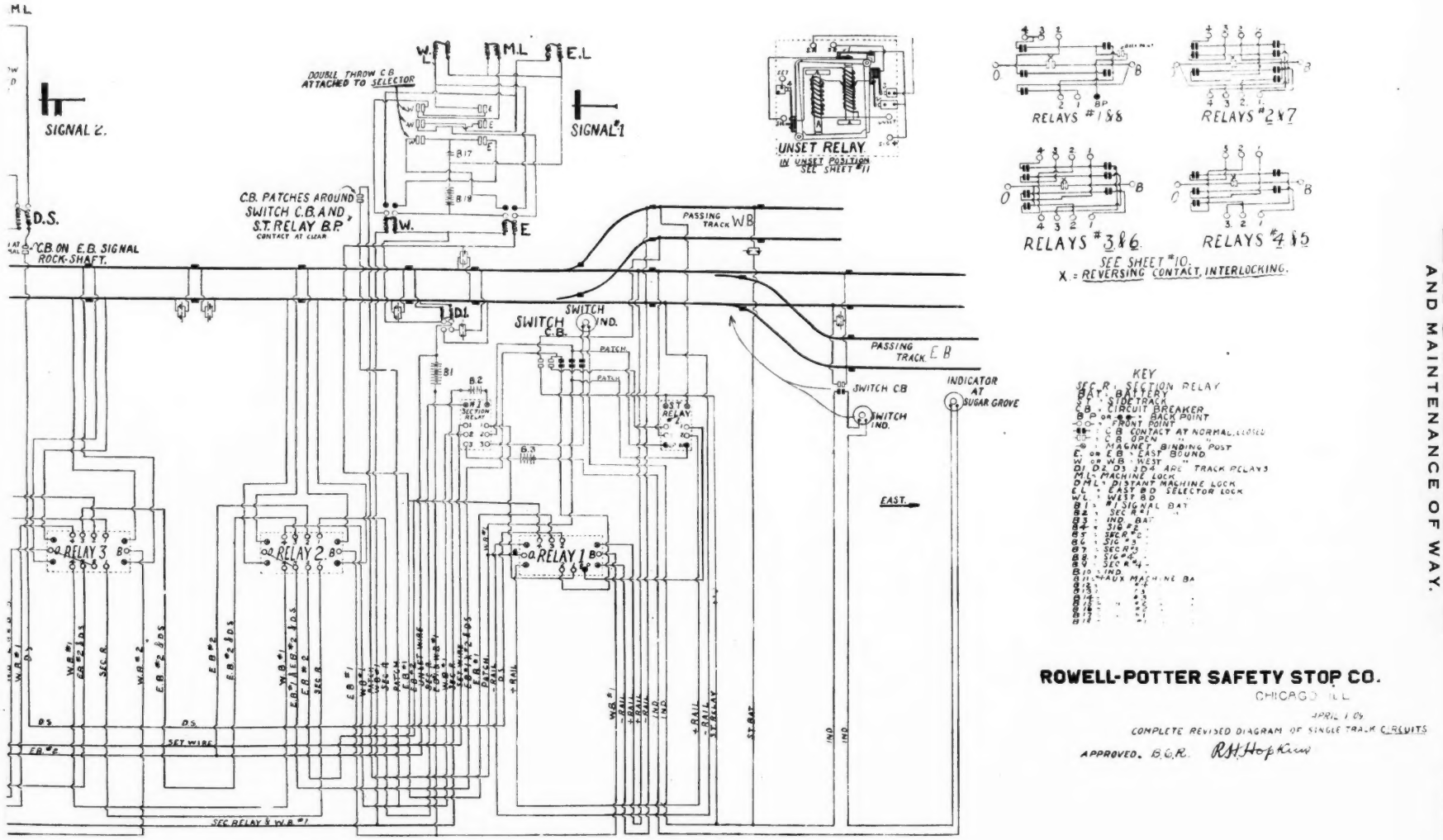


Fig. 12. Continued.

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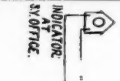

Fig. 14.

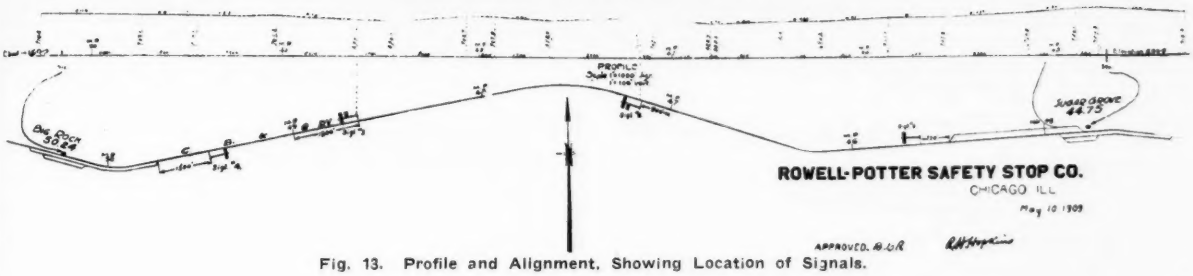

Fig. 13. Profile and Alignment, Showing Location of Signals.

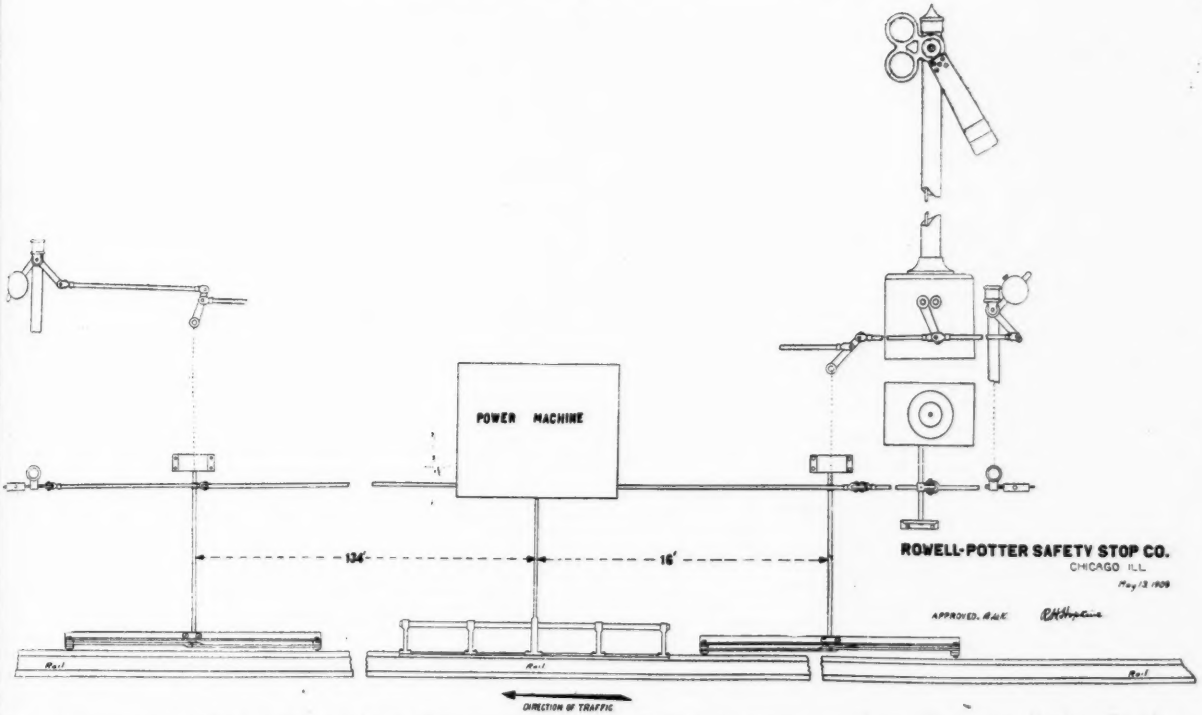

Fig. 14. Diagram of Signal, Showing Relative Positions of Semaphore, Track Instruments, and Power Machine as Used on Double Track.

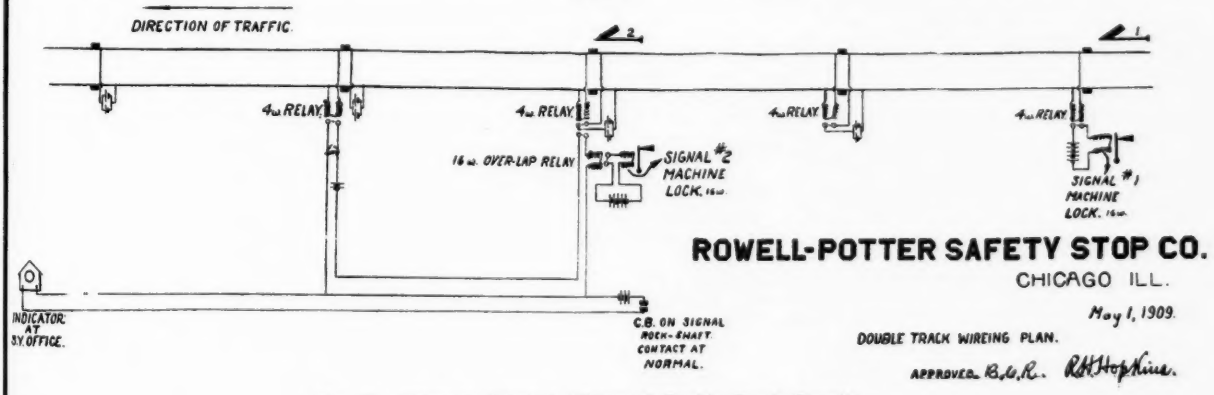
DIRECTION OF TRAFFIC.
4 m. RELAY
4 m. RELAY
4 m. RELAY
4 m. RELAY
16 m. OVER-LAP RELAY
SIGNAL #2 MACHINE LOCK. 16 m.
SIGNAL #1 MACHINE LOCK. 16 m.
INDICATOR AT S.Y. OFFICE.
C.B. ON SIGNAL ROCK-SHAFT CONTACT AT NORMAL.
ROWELL-POTTER SAFETY STOP CO.
CHICAGO ILL.
May 1, 1909.
DOUBLE TRACK WIREING PLAN.
APPROVED. B. & O. R. R. Hopkins.

Fig. 15. Diagram Showing Wiring of Double Track Circuits.

D. D is then free and both C and D are forced upward. The travel of D forces E upward off its seat and allows the air to escape down through the machine. The object of allowing the air to blow down through the machine is to keep the machine clean.

When E is forced upward KK′ being pressed inward by the pressure of springs LL catch in ratchet teeth on E and hold it up. To close this valve it is necessary to press button J which rocks KK′ on their fulcrum. L′ disengages them from E and allows it to drop.

The object of lock N on plunger D is to prevent the machine from being operated by anything except the instrument that was intended to operate it.

Diagram of Signal.

Fig. 9.

Showing relative positions of track instruments, power machine, semaphore, and connections.

AA′—Are the two track instruments.

BB′—Are their respective counterweights which would carry them to danger in case of a breakage of their connection.

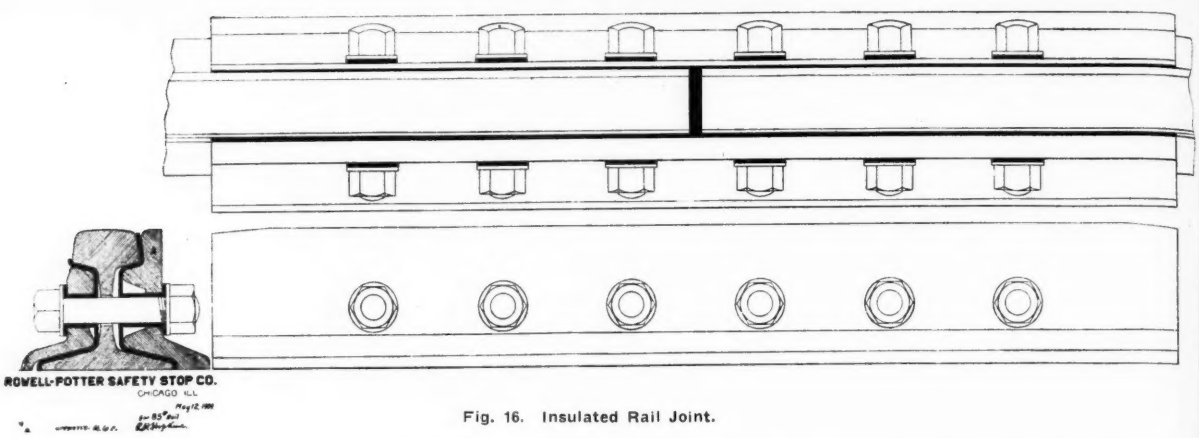

Fig. 16. Insulated Rail Joint.

C—Is pipe-line connection between A and A′.

D—Is the semaphore signal.

EE′—Are the connections from signal bars O and P in the selector box of power machine to signal rock shafts FF′.

G—Is tread bar which winds power machine.

H—Is three-arm signal showing distant or green blade which is operated by a small spring motor, placed in the base of the semaphore pole, and the shaft with universal joints, shown in dotted lines, between power machine and D is the method of connecting the power of G to this motor for the purpose of winding it. In this installation signals 2 and 3 had green semaphore arms for the purpose of indicating condition of main track at the next station.

The two track instruments 180 feet apart and connected rigidly in opposed positions are to give positive protection against a false indication by the signal. One of these track instruments is up and the other down at all times, and the apparatus designed to prevent stopping the signal in any position where one or the other of these track instruments would not be in a position to apply the brakes.

The track section protected by a signal being clear, an approaching train would clear the board governing its direction and lower the first track instrument, in order of approach, and, of course, raise the second one. This is accomplished through the medium of the selector (see description of power machine, Figs. 1, 2 and 3). When the engine passes the first track instrument the current is cut off the lock of the power machine and the signal instantly goes to danger, and reverses the track instruments, i. e., puts the one the engine has just passed to danger and pulls the one just in front down to clear, and the train is unmolested in its onward course. But, should anything happen to the mechanism, so that it could not instantly reverse and display the danger signal, the train would be automatically stopped.

Reversing Relay.

Fig. 10.

Is the instrument that makes an electric contact in accordance with the direction of the train and at the same time performs all the functions of two track relays.

1—Is the armature of one set of magnets.

2—Is the armature of the other set of magnets.

XX—Are signal-circuit contact points which complete the circuit when the magnets are deenergized in the proper order. The top contacts (shown in 1 and 2) are connected in series when it is desired that the deenergizing of either magnet shall break the circuits; they can be arranged so that but one magnet will break any desired number.

The signal circuit which passes through XX is brought into the relay at binding post B and out at O.

3—Illustrates contact made by XX when magnets are deenergized in the proper order.

4—Illustrates the position of contact points XX when both magnets are deenergized in the reverse order.

5—Is an enlarged drawing showing the proper angles and curvatures of XX.

Each pair of magnets of this instrument has a separate track section, and the order in which these track sections are short-circuited by a train determines whether the circuit is completed at XX or not. From this it will be seen that it is only necessary to connect these magnets to the rails properly to cause them to make the contact in the direction desired. For wiring diagram of this instrument, see Wiring Plan, Fig. 12.

Unset Relay for Single-Track Circuits.

Fig. 11.

The office of this instrument is to close the circuit and let a following train into the section as soon as the first train has proceeded a safe distance past the second signal, and also break all opposed circuits before said train can enter. In this installation there were two sets of instruments, one for each direction.

A—Is an electro-magnet called the unset.

A′—Is an electro-magnet called the set.

Contact points 1 make and break the signal circuit.

Contact points 2 make and break the circuit for magnet A.

Contact points 3 make and brake the opposing section relay circuit.

Contact points 4 make and break circuit of magnet A′.

5—Is armature of A fast to a right-angle crank pivoted at 8.

6—Is armature of A′ fast to a right-angle crank pivoted at 9.

Operation.

A train entering the section must, before its signal circuit can be completed, energize magnet A. Armature 5 is attracted; pulls the hook off the end of the crank arm of 6 at 7 against the pressure of spring B. 6 is forced upward by the pressure of spring C. This operation makes contacts 1 and 4 and breaks 2 and 3, and the circuit for the signal governing this train's entrance upon the section is completed at 1 and all opposed circuits are broken at 3.

The circuit of A′ is closed at 4 but is held open at the track relays, which are short-circuited by the oncoming train until such time as the train has passed under the protection of the second signal in the section, when it is completed by the recovery of the track relays behind the train and resets, i. e., position shown in drawing, and the circuits are ready for a following train. When this occurs the first train that entered has advanced to a position where it will hold the opposed circuits open by means of the track relays of the section it is traversing. It will be seen by the above that the magnets of this instrument are energized but an instant for each operation. The energizing of A makes a circuit for A′ and breaks its own, and the energizing of A′ makes a circuit for A and breaks its own.

Diagram of Single-Track Circuits.
Fig. 12.

Operation of westbound circuits to clear signal No. 1, which controls entrance to section.

Positive of battery of signal No. 1 is carried into posts "B" on relays 1 and 2.

Contact made at X relay No. 1 (see description of reversing relay Fig. 10) closes unset circuit (see Fig. 11) as follows:

Out of post O of relay 1 through main-line contact of switch-circuit breaker through contact between posts 2—2 of section relay No. 1, through contacts between posts 4—4 of relay No. 2, thence through contacts between posts 4—4 of relay No. 3, thence through contact between posts 1—1 on section relay No. 2, thence through contact between posts 2—2 on relay No. 4, thence into post marked "sig +" on westbound unset relay, thence through contact 2 and magnets A (see Fig. 11) out of post marked "unset" back on through wire to negative side of battery.

The relay being thus unset, all opposed circuits are opened, and the return of the circuit is switched and returns via contact 1 post marked "sig —," through wire common to the circuits of section relays 2 and 1, and drops off at signal No. 1, passing through magnets of signal relay "W," thence through contact of relay D1, thence to negative side of battery.

Side-Track Circuit.

Train entering section from side track, with switch set on side track, a train thereon short circuits the side-track relay (when switch is on main line but one rail of side track is used for this circuit, hence switch must be opened before train short-circuits it). This drops the "B" end of relay No. 1, because the first track section is wired through front point of side-track relay. When fouling point of switch is reached, the train is then on the second track section of relay No. 1 and the circuit is completed, so far as relay No. 1 is concerned, the same as would be done by train on main line. The current flows from X out of post O on relay No. 1 through back-point contact on side-track relay instead of through main-line contact point in switch-circuit breaker, as with main-line circuit. There is a patch wire running around switch-circuit breaker and back pont of side-track relay through a circuit breaker on signal No. 1 which makes with signal at clear. This is to hold the signal circuit in case the side-track relay recovers or the switch is set before the train reaches the signal, a necessity for short trains.

Clearing Circuit for Westbound Signal 2.

Positive of battery of signal 2 is carried into posts "B" of relays 3 and 4, contact made at X, relay 3, leaves relay at binding post O through contacts between posts 3—3, relays 4 and 5, thence through contacts between 2—2, relay 6, thence back through contact between posts 3—3 of section relay 2, thence through magnets of signal relay "W," thence through contact point of relay D2 to negative of battery.

Clearing Circuit for Westbound Signal No. 3, when Main Line at Big Rock is Clear.

Positive of battery of signal 3 is carried into posts "B" of relays 5 and 6, out of post O of relay 5 through contacts between posts 3—3 of relay 6, thence through contacts between posts 3—3, relay 7, thence through main-line contact in switch-circuit breaker, thence through contacts between posts 2 and 3 on delay 8, thence back through contact between posts 2—2 on relay 7, thence via unset wire to signal 3, where it is taken off and passed through magnets of relay "W" through contact on relay D3 to negative of battery.

Clearing Circuit for Signal No. 3 Westbound when Main Line at Big Rock is Occupied and Switch Set for Passing Track.

It is the same circuit up to the switch-circuit breaker where the main-line contact is now open and side-track contact closed; through side-track contact, thence through contact between posts 2—2 of side-track relay No. 2, thence through one back point and one front point between posts BP and 3 on relay 8, and returns from post 3 via the same route as main-line circuit.

Distant-Signal Circuit—Main Line Clear at Big Rock.

It travels the same route as home-signal circuit up to post 2 of relay No. 8, thence through contacts between posts 2—2 on relay No. 8, thence returns on its own wire through a circuit breaker (contact made at clear) on westbound home signal, thence through magnets of signal relay DS, thence through contacts on relay D3 to negative of battery.

With the main line at Big Rock occupied and switch set for siding the circuit is held open at relay 8. The distant-signal circuit can not be completed unless the second block section ahead is clear.

Clearing Circuit for Signal 4 Westbound.

Positive of battery of signal No. 4 is carried into posts "B" of relays 7 and 8, out of post O of relay 7, jumped to post 3, out of 3 to main-line contact of switch-circuit breaker, through contacts between posts 2 and 4 of relay 8, thence back through magnet of signal relay W, thence through contact on relay D4, thence to negative of battery.

Clearing Circuit—When Main Line is Occupied and Switch Set for Passing Track.

It is the same circuit up to the switch-circuit breaker where main-line contact is now open and side-track contact closed: through side-track contact: thence through one back point and one front point between posts No. 2 and No. 4 of relay No. 8; thence back via the same route as main-line circuit.

Machine Circuit.

Refer to Signal No. 4, Fig. 12, for characters used.

Westbound train, selector in eastbound position, relay "W" is energized closing contact WFP. Current flows from battery B12 through magnets WL of selector lock, through contact No. 1E in contact box of selector, back through contact WFP to negative side of battery. The completion of this circuit allows selector to operate, and current is switched through machine lock ML back through contact 1W and contact WFP to negative side of battery.

When selector is in proper position for approaching train current goes direct to ML without moving selector.

Eastbound circuit is a duplicate using relay E, contacts EFP and selector contact 2W.

There is at each machine an auxiliary battery used on closed circuit for holding armature of selector magnet in either position.

Current flows from battery B11 through contact in selector box 3E through back point WBP on relay W through EL back to negative side of battery. With selector in opposite position current flows from B11 through 3W and EBP through WL back to negative of battery.

This completes the operation of the circuits for a westbound train with the exception of the set circuit, i. e., restoring the unset relay to its normal position, and the section relay and indicator circuits.

Set Circuits.

Current starts from battery at signal No. 1, thence through a contact between posts B and 1 on relay No. 1, thence through a contact between posts 1—1 on section relay 1, thence over its own wire to a post marked "set" on the unset relay, thence through contact 4, which is made when the relay is unset, thence through magnets A1 and back over the unset wire to negative of battery.

Section Relay No. 1.

Current flows from battery through magnets of relay, thence through contacts between posts 1—1 on relay No. 2, thence through contacts between posts 1—1 on relay No. 3, thence through contact between posts 2—2 on section relay No. 2, thence back to negative side of battery.

Section Relay No. 2.

Current flows from battery through contacts between posts 1—1 on relay No. 4, thence through contact 3 between two

posts SR—SR on eastbound unset relay, thence back through its own magnets to negative side of battery.

The circuits of section relays Nos. 3 and 4 are duplicates of Nos. 1 and 2, controlling entrance to section of eastbound trains, as Nos. 1 and 2 do of westbound trains.

Indicator Circuits.

Starts from battery to contact on section relay No. 1 and thence through both switch and station indicators, in series, passing through a circuit breaker at each switch and back to battery.

Eastbound circuits are exact duplicates reading from west to east.

A careful study of these circuits may lead one to think that there are more contacts or openings in them than necessary, and consequently more wire. If we admit that one opening of a circuit is equally as safe as two, this criticism will hold good. This installation was made with a view to providing absolute protection first, then as high a percentage of operation as possible. These circuits are so overlapped and arranged that the same object which closes one opens another and can not close one without opening another, because it can not assume two positions at once. This is done to prevent lightning from fusing relay points, so as to allow two trains to get together.

This was considered of more importance in this installation than the saving of wire and a few contact points.

Fig. 13.

Map of profile and alignment of the C., B. & Q. Ry. Co.'s track, between Sugar Grove and Big Rock, showing location of signals.

Fig. 14.

Diagram of signal showing relative position of track instruments, power machine, semaphore, and connections as used in double-track blocking. The difference between this and the single-track signals shown on Fig. 9 are:

There is no selector, and the signal and track instruments are connected direct to power machine, and the signals are arranged on the normal clear instead of normal danger plan.

Fig. 15.

Diagram of circuits of double-track installation.

Insulated Rail Joint.

Fig. 16.

The insulated rail joint used in this installation consists of an outside splice bar A, having ribs extending under the ball and over the base of the rail, a wide base resting upon the ties, which gives it a firm foundation, and a top extension on a level with the tread of the rail, the ends of which are slightly tapered, with insulation between it and the rail. The inside bar is a standard splice bar with insulation between it and the rail.

The object of the outside bar is to carry the load directly upon the ties instead of putting a greater weight upon the insulation than it can sustain.

There is always some deflection to a rail as a train passes over it. When a rail deflects it forms an arc of a circle; when deflected at a joint the ends of the rails form an obtuse angle, because there is no joint made of sufficient strength to compel the ends of the rails to bend uniformly. The angle formed by the ends of the rails, when a joint is deflected, cuts out and destroys insulating material very quickly.

It being practically impossible to force the rails to form an arc of a circle when deflected at a joint, the next best thing to do is to stop the deflection, i. e., relieve the load on the rails and place it directly upon the ties, which is what this outside splice bar A is intended to accomplish.

It will be noted that in this installation the single-track signals are double arms, i. e., two arms on one mast. Should it be desirable to have the governing signal always on the right of the track, it is a simple matter to put up another mast and run a connection from the signal bar in the selector to it.

Should it be desirable to locate the signals in one direction different from those of the opposite direction, on account of grades, curves, etc., they can be installed as units. In this case the power machine would reverse the track instruments only for opposed trains and would not clear the board excepting when approached by a train in the direction in which it governs.

The single-track signals in this installation were arranged on the normal-danger plan. Should it, for any reason, be desirable to arrange them on the normal-clear plan it can be readily done.

Winston & Co., of Richmond, Va., has been given the contract for the construction of the final section of the Lexington Eastern extension into the mountains. They will build twelve miles east of Whitesburg, in Letcher county, which is without railroad facilities. The other contractors have begun work and have been instructed to rush to completion.

Carl Hall & Co. were awarded a contract by the Great Northern for about seventy-five thousand yards of earth excavating near Grand Rapids, Minn., work to be started immediately.

Railway companies are building at Oakland, on San Francisco bay, great piers and warehouses, with electric cranes to transfer cargoes from ship to car and from car to ship, that will involve an expenditure of upward of $50,000,000. In addition to this, the city of Oakland has already voted bonds to the extent of $2,500,000 for docks and warehouses and a belt railroad along its inner harbor, where the United States government is engaged in improvements on a continuous system of appropriations which will total $2,500,000.

The Boston & Maine is installing 1,000 equipments for burning acetylene gas in signal lights. These are being put in on the Portland, Fitchburg and Southern divisions. It is intended to equip the whole system with this method of signal lighting. The acetylene lights, it is said, will burn 112 days without attention. This equipment is also being installed on the Maine Central between Portland and Cumberland Junction on all automatic block signals and isolated mechanical interlocking plants.

The Baltimore & Ohio has let a contract to the Federal Signal Co. for installing an interlocking plant at its bridge No. 402 in Cleveland, Ohio. The plant will include six dwarf signals, one switch, five derails, six facing point locks, one bridge lock, and four rail locks, operated by 19 working levers. The interlocking machine will also contain 13 spare spaces. There will be no night signals.

L. J. Ferritor, division superintendent of the Wabash at Decatur, Ill., has been appointed superintendent of the Northern and Southern divisions of the Chicago & Alton, with office at Bloomington, Ill., succeeding P. G. Walton, formerly superintendent Northern division, resigned, and C. F. Smith, superintendent Southern division, assigned to other duties.

H. J. Horn, assistant general manager of the Chicago, Burlington & Quincy lines west of the Missouri river, at Omaha, Neb., has been appointed assistant to the president of the New York, New Haven & Hartford, with office at New Haven, Conn.

E. M. Rine, superintendent of the Delaware, Lackawanna & Western, at Hoboken, N. J., has been appointed assistant general superintendent, with office at Scranton, Pa. S. S. Stone, assistant superintendent at Hoboken, has just been appointed acting superintendent of the Morris & Essex division, succeeding Mr. Rine, and H. H. Shepard, superintendent of the Scranton division, at Scranton, has been granted an extended leave of absence and his duties will be performed by the assistant general superintendent. F. M. Benning, passenger trainmaster, at Hoboken, has been appointed assistant superintendant of the Morris & Essex division, with office at Hoboken, and J. W. Pierce succeeds Mr. Benning.

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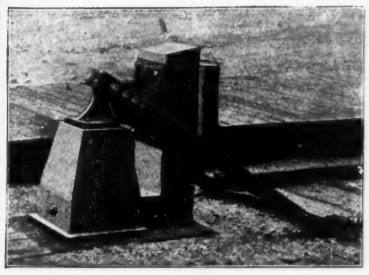

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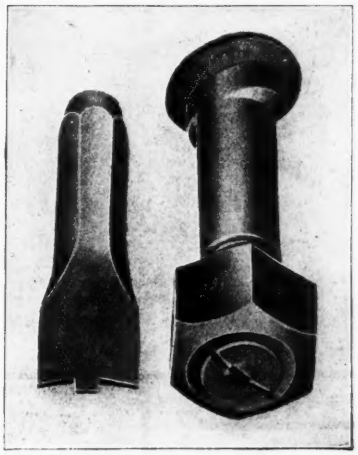

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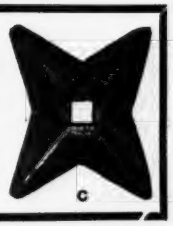

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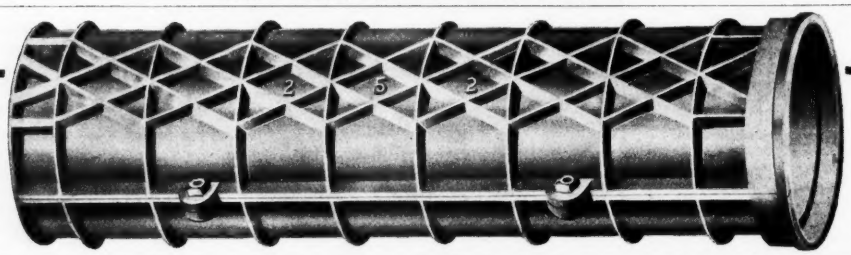

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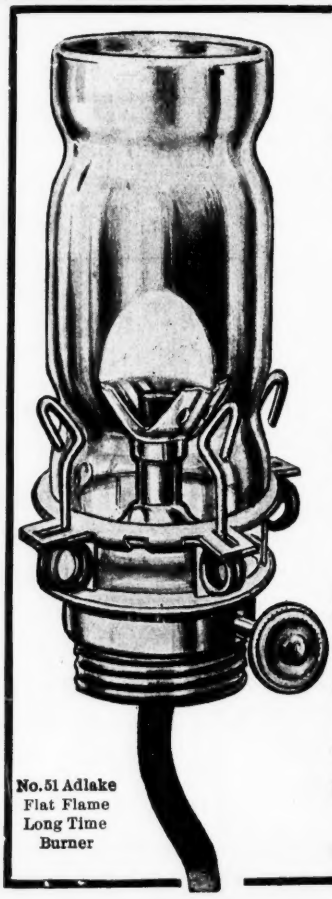

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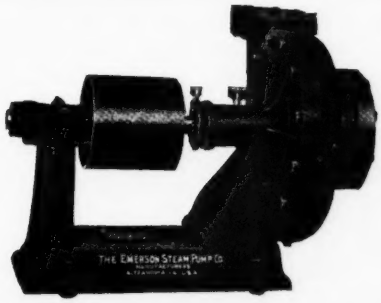

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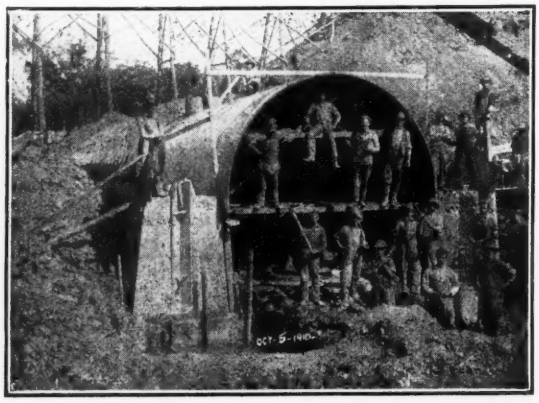

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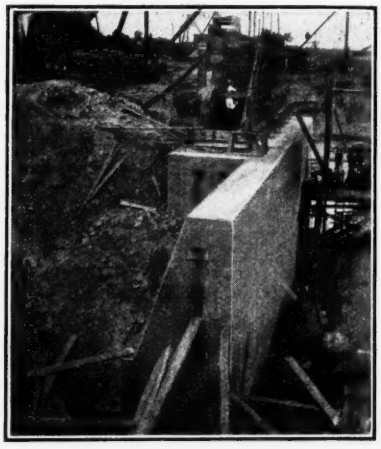

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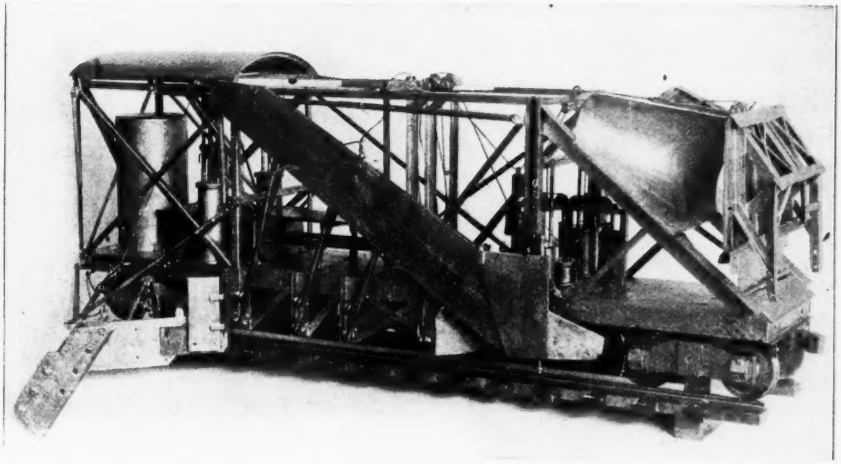

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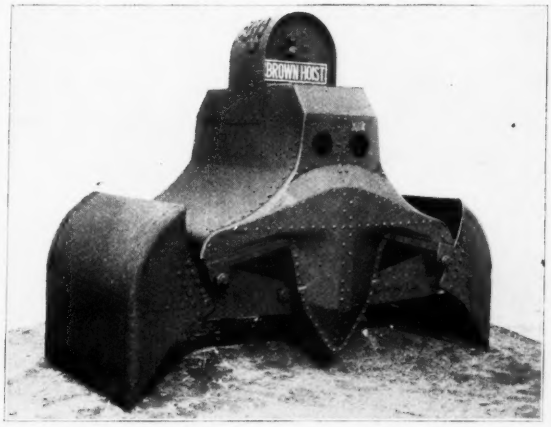

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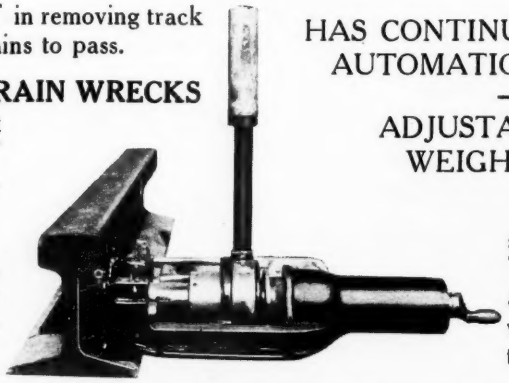

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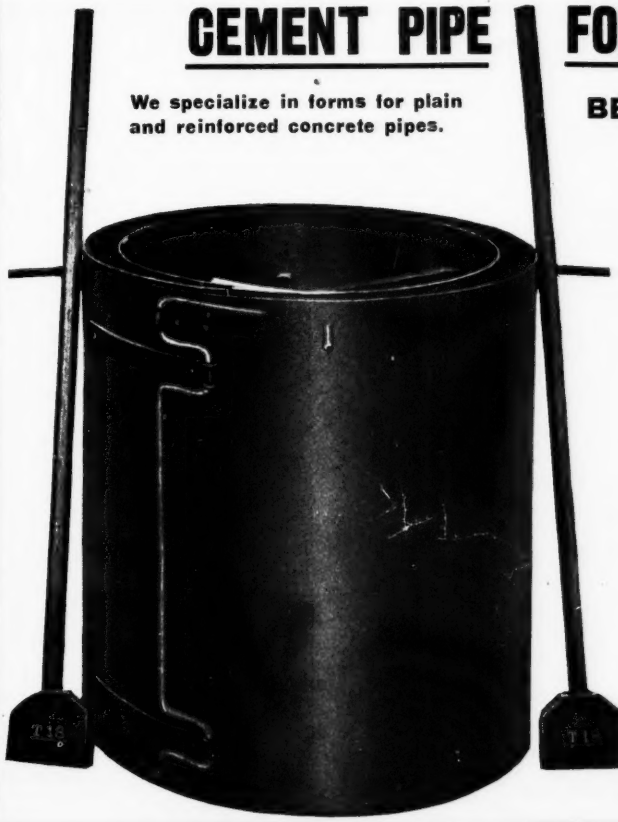

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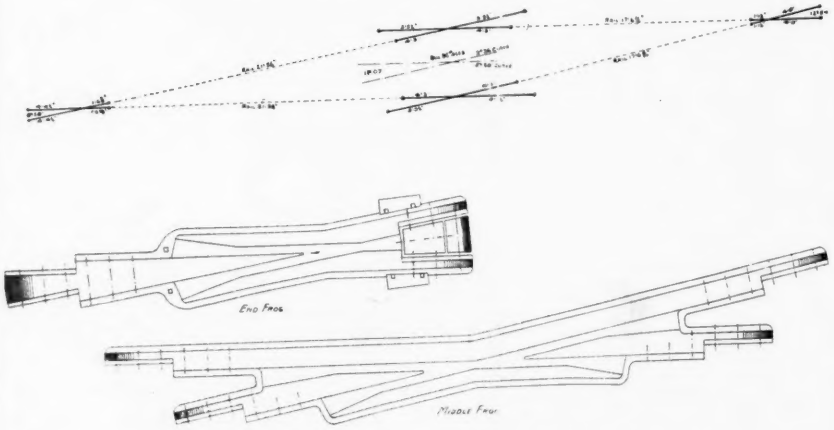

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